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EDITORIAL

With the imminent departure of so many members to South Africa to take part in the Seventh Commonwealth Mining and Metallurgical Congress the annual dinner of the Institution of Mining and Metallurgy was this year held considerably earlier than usual. It took place on March 21 in the Carpenters Hall, newly arisen on its original pre-bombing site in Throgmorton Avenue in the City of London. The toast of the Institution was proposed by Lord Fleck, president of the Society of Chemical Industry, Professor David Williams, this year's Institution president, in his reply briefly reviewing current activities. Dr. Williams made preliminary announcement of the principal awards for 1961, this year's gold medal, for instance, going to Lord Baillieu, for his long services to the mining industry. Honorary Membership, Dr. Williams said, had been awarded to Professor Emeritus C. W. Dannatt, who, it is sad to say, has since died after a long illness. At the dinner the toast of the guests, proposed by Mr. A. R. O. Williams, president-elect, elicited a felicitous reply from Sir William Pugh, former director of the Geological Survey, who showed a proper appreciation of the position of metal mining in the national economy.

The Outlook for Copper

Speaking at an informal meeting of Rhodesian Selection Trust shareholders in London earlier this month the chairman, Sir Ronald Prain, suggested that the short-term outlook for copper was obscured by conflicting forces—*i.e.*, the fact that the statistical position reflected a condition of over-supply, while political uncertainties in the producing areas, particularly in Africa, weighed heavily on the market. Thus, not for the first time, Sir Ronald said, political factors were superimposed on economic factors. In the circumstances he thought that it would be unrealistic for the producing industry to refuse to face increased curtailment merely because the price was sustained. That would, he felt, mean a still further aggravation of the statistical position, with all the long-term problems that that would bring.

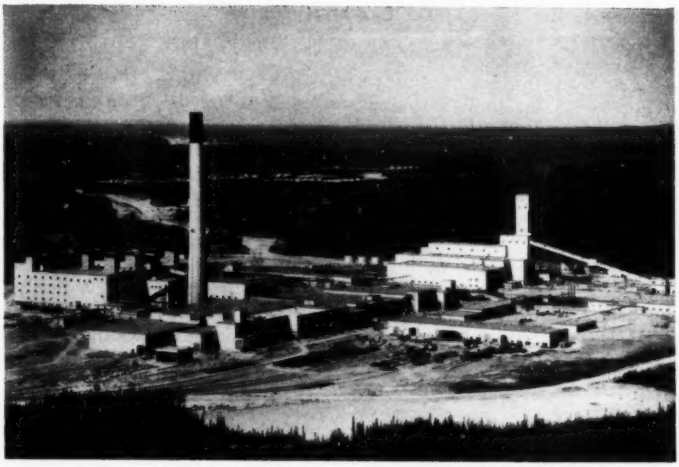
Sir Ronald was not, however, unduly pessimistic regarding the future. He did not advocate, but did suggest that the curtailment policy should be based on statistical evidence rather than on market factors. At the present moment there were, he said, other factors—such as, the question of the possibility of a recovery in copper consumption in the United States. Generally speaking consumption of copper in Europe, which had made a spectacular advance in the last year or two, and which was now far in excess of that of the United States, had been maintained at a satisfactory level. A business recovery in the United States might very well alter the copper statistical position in the course of a few weeks. That was only one factor of many which were being closely watched by the copper-producing industry.

With regard to the long-term prospects for the metal his confidence remained unchanged. While forecasting was always dangerous, studies which had been made indicated that, provided the price of copper did not rise to a level which would lead to substitution, and provided also that world peacetime prosperity continued, some excess production capacity could continue until about 1963 and a rough balance be reached in about 1964. In the meantime producers were far from being complacent about the need for increased efforts to promote the uses of copper, to publicize its qualities, and to meet competition from other materials.

Production Starts at Mystery Lake

On March 26 the Hon. Duff Roblin, Premier of Manitoba, and Mr. J. Roy Gordon, President of the International Nickel Co. of Canada, cut ceremoniously a ribbon of pure nickel to signify the start of production at the company's new nickel plant at Thompson. This project, thus dedicated, will add 75,000,000 lb. of nickel annually to Canadian production. The new production capacity makes Thompson the free world's biggest nickel-producing centre next to Inco's operations in the Sudbury District. It is also the free world's first-fully integrated nickel plant, employing some 1,800 men and women, a figure which within a short time will increase to over 2,000. The initial expenditure totalled $185,000,000, of which Inco ventured $130,000,000, and this makes Thompson the largest single investment in Manitoba.

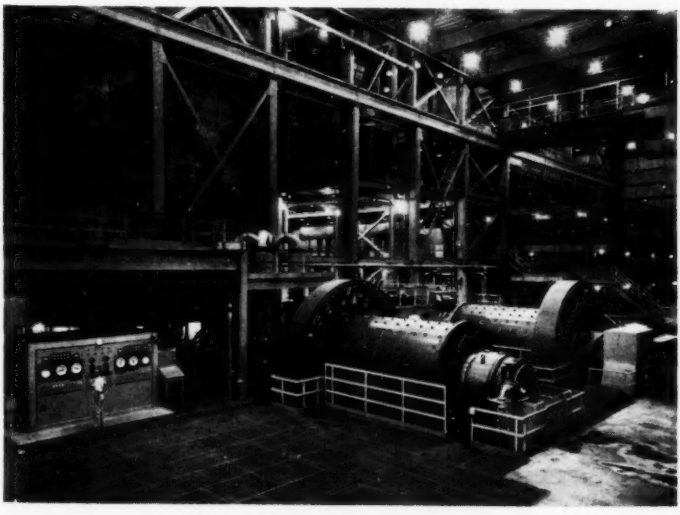
In a brief description of operations at Thompson contained in a brochure issued for



Plant-Site Area, Thompson, Manitoba.

the occasion it is noted that the Thompson ore-bodies are being mined principally by horizontal cut-and-fill and by the time full-scale commercial operations have been reached some 120 cut-and-fill stopes will have been developed. The deposits contain nickel sulphide ores of the same general type as are mined in the Sudbury District, but are low in copper. Minor quantities of cobalt, platinum, palladium, gold, and silver are also present. At the mill 5,000 tons of ore are treated daily, the concentrate then being fluid-roasted at the smelter before being treated in electric furnaces. The Bessemer matte obtained is cast directly into refinery anodes and the nickel recovered by direct electrolysis. Thereafter the electrolytic solutions are treated for the removal of impurities and for the recovery of cobalt, which is shipped as an oxide. Spent anodes, together with an adhering high-sulphur residue, are crushed and washed. A filter cake, obtained from the washings, is melted and the sulphur is removed, leaving a precious-metals residue which is shipped to the Copper Cliff refinery for further processing.

All this has risen from the wilderness in the last five years and within the next two years there will be over 2,000 men, women



Inside the New Mill at Mystery Lake.

and children living in Thompson, the town named after Dr. John F. Thompson, now honorary chairman of the Inco board. While the plant and town were taking form hydro-electric power was being developed on the Nelson River and 53 miles to the north-east the Manitoba Hydro-Electric Board was constructing the Kelsey power plant, planned to be the first of a string of power stations designed to serve the industrial needs of the Province.

With Thompson fully at work the free world nickel production capacity is now at an all-time "high." Exclusive of Cuban sources it is estimated to exceed 600,000,000 lb. in 1961, of which Canada accounts for the lion's share. International Nickel's operations in the Sudbury District, steadily expanded through the years, have an annual production capacity of 310,000,000 lb. and to this is now added Thompson's 75,000,000 lb., bringing Inco's annual total production capacity to over 385,000,000 lb.

Northern Rhodesia in 1960

Despite the fall in the price of copper and the restriction imposed in October last the mineral output of the Protectorate of Northern Rhodesia for 1960, valued at £128,700,000, was £9,000,000 higher than in the previous year. Figures released by the Ministry of Labour and Mines show that the copper output contributed £121,100,000 to the total; cobalt, £2,300,000; zinc, £2,700,000; lead, £1,000,000; manganese, £750,000, and limestone £500,000 during the year just ended. "Provided progress in the mining industry is continued at the same rate and markets remain stable there is no reason to think that the achievement will not be at least matched, if not bettered," in the current year. Output from the territory's mineral industry, it is emphasized, is governed more by world demand than by any limitations of potential productive capacity.

The Ministry takes note of the fact that, in spite of the lower average prices for the Protectorate's main exports, productivity continues to rise. Industry, it is pointed out, employed only 2% more workers for the 5% increase recorded. These workers took home more money—9·4% more for each African, and 4·4% more for each European worker. Workers in the mineral industry of the Protectorate now number more than 50,000, of whom some 42,000 are African.

Cornish Mining Development Association

The annual meeting of the Cornish Mining Development Association is to be held later this month in Camborne, but it is evident from the report for the year 1960–61 recently made available that taxation revision is still considered its most important object. It is its view that the tax reliefs needed to encourage a revival of the metal-mining industry "would cost the Exchequer little or nothing for there are now no new mining companies to tax." If, however, such tax reliefs resulted in revival there would be new revenue within a few years. Exception is also taken to the effect of the Government's new re-rating proposals, which are thought likely to bear with particular severity on the few companies still active in the West Country.

The report draws attention to the fact that in the year under review a team of geologists equipped with diving apparatus examined under-water rock exposures on the north coast between St. Agnes and Perranporth and for a mile off-shore, work which is to be followed up by intensive diamond drilling at Cligga Head. "A considerable proportion of the mineral potential of Cornwall probably lies beneath the sea and, as it is now possible by diving to examine the geology for about two miles off-shore, the total area of prospecting ground in West Cornwall—*i.e.*, west of a line joining Newquay and Truro—is increased by 55%. Part of this underwater work has already been noted in the MAGAZINE, a contributor to the February issue, for example, having described a successful attempt to locate the source of flooding from the sea-bed into the old Levant sett.

The Association is naturally also interested in the attempt being made to gain permission to explore the Carnelloe prospect on the cliffs west of Zennor. As was noted, also in the February issue, a public enquiry regarding this matter has been fixed for May 10 in Penzance. The Association is to support the application, since it feels that this little property, given a short trial in 1872–3, is on the junction of the slate, greenstone, and granite rocks and likely to develop "seawards like the celebrated Levant and Botallack mines." The surface works of the mine would be invisible from Zennor, it is pointed out, and "in any case it could have little if any adverse effect on the scenery of the area."

MONTHLY REVIEW

Introduction.—The decision of South Africa to leave the Commonwealth has added a further degree of political uncertainty as to the course events are likely to take further north in the Central African Federation. At the same time there is uneasiness regarding conditions in South-East Asia, with the result that commodity prices tend to firm. The effect of conditions such as this on the copper price was reviewed by Sir Ronald Prain earlier this month, a note on this appearing on an earlier page.

South Africa.—The output of the gold mines, members of the Transvaal and Orange Free State Chamber of Mines, for February totalled 1,759,373 oz., making with 32,046 oz. from outside producers a total of 1,791,419 oz. for the month. At the end of February there were 396,533 natives at work in the gold mines as compared with 384,816 at the end of the previous month. The figures for March corresponding show 1,837,280 oz. and 38,843 oz., a total of 1,876,123 oz. for the month, with 398,626 natives at work in the gold mines.

The accounts of DAGGAFONTEIN MINES for 1960 show a surplus of £4,481,924 and a balance of £4,914,389 available, of which £1,400,000 is required for dividends equal to 4s. a share. In the year 2,743,000 tons of ore was milled and 554,702 oz. of gold recovered, while the uranium plant produced 546,775 lb. of oxide. At December 31 last the ore reserves were estimated to be 7,576,200 tons averaging 5·10 dwt. over 43·52 in., of which 3,303,000 tons on Kimberley Reef averaged 5·69 dwt. in gold with 0·385 lb. uranium per ton.

EAST DAGGAFONTEIN MINES reports a profit of £514,391 for 1960, the accounts showing £737,655 available, of which dividends equal to 1s. 4½d. a share required £256,437. The mill treated 1,270,000 tons of ore in the year and recovered 215,874 oz. of gold. Ore reserves at December 31 last were estimated to be 4,733,000 tons averaging 4·62 dwt. in value over 36·61 in.

The report of BRAKPAN MINES for 1960 declares a profit of £222,236, the accounts showing £559,732 available, of which £201,250 has been transferred to "Profits Appropriated for Capital Expenditure" arising from repayments of share capital. The mill crushed 1,720,000 tons of ore in the year and 208,793 oz. of gold were recovered. At the end of 1960 the ore reserves were calculated as 1,340,000 tons averaging 4·87 dwt. over 56·32 in.

The operations of SPRINGS MINES in the year to December 31 last resulted in a surplus of £203,870, the accounts showing £450,618 available for appropriation. Of this amount £252,750 has been taken against the repayment of share capital. In the year the treatment of 1,194,000 tons of ore yielded 165,494 oz. of gold. Ore reserves at the end of 1960 are given as 615,000 tons averaging 4·03 dwt. over 42·89 in.

The accounts of SOUTH AFRICAN LAND AND EXPLORATION for 1960 show a surplus of £485,867 and £848,656 available, of which £123,750 is required for dividends equal to 1s. a share. From 1,174,800 tons of ore treated 243,886 oz. of gold was recovered. At December 31 last the ore reserves were estimated to be 3,344,300 tons averaging 6·13 dwt. in value over 44·61 in. The report says that a considerable portion of the preparatory work for the sinking of No. 3 Sub-vertical Shaft was completed during the year and work is now in progress with the sinking of the headgear portion of the shaft and support of the hoist chambers. It is anticipated that normal sinking operations will commence in July, 1961.

At the end of 1960 the main shaft at WESTERN AREAS GOLD MINING had reached a depth of 4,507 ft. and on March 3 last it had reached its final depth at 4,980 ft. The ventilation shaft was completed at 3,616 ft. in September last. Development is now under way, the report for 1960 stating that progress is well ahead of schedule.

RANDFONTEIN ESTATES GOLD MINING reports a profit of £2,735,336 for 1960, the accounts showing £3,395,304 available. Of this amount dividends equal to 3s. a share require £1,219,066. In the year 49,719 oz. of gold were recovered from the 260,000 tons of ore treated, while the 1,804,000 tons milled in the uranium division yielded 92,614 oz. of gold and 1,826,028 lb. of uranium oxide. Reserves in the gold division at December 31 last are given as 100,000 tons averaging 4·9 dwt., while those in the uranium division totalled 2,007,000 tons averaging 1·6 dwt. in gold and 1·3 lb. of uranium oxide per ton.

At GOVERNMENT GOLD MINING AREAS last year the mining of limited tonnages on the Kimberley Reef and the Black Reef was continued, but difficulty was experienced towards the end of the year in maintaining

the current rate of milling. In February, 1961, steps were taken to close down operations on the Kimberley Reef, the effect of which will be to reduce the tonnage milled to about 35,000 tons per month; it is anticipated that this rate of milling can be maintained throughout 1961. Ore reserves at December 31, 1960, amounted to 152,000 tons and consisted mainly of pillars in the workings on the Black Reef series. The treatment of old residues, both sand and slimes, was continued during the year. The pyrite plant operated satisfactorily at full capacity.

The report of NEW STATE AREAS for 1960 states that the dismantling of plant in the reduction works continued during the year, but certain alterations were made to a portion of the plant to permit the milling and treatment on a small scale of gold-bearing material available in the form of concrete floors, scalings, and residues. It is anticipated that revenue from the clean-up will cease during 1961.

The operations of EAST CHAMP D'OR GOLD MINING in 1960 resulted in a profit of £126,846, the accounts showing £190,152 for appropriation, of which dividends equal to 6d. a share required £103,950. In the year 147,600 tons of ore milled for uranium yielded 114,871 lb. of oxide and 3,818 oz. of gold, while 17,900 tons treated for gold yielded 2,717 oz.

With the recent dividend notice shareholders in RUSTENBURG PLATINUM MINES are informed that the rate of production at the company's mines, which continues to be in excess of the estimated annual level of sales, will be reduced as the company's platinum stocks rise to the desired levels.

LYDENBURG PLATINUM reports a profit of £272,978 for the year to October 31 last, dividends equal to 1s. 4½d. a share requiring £247,500 of the £314,030 available.

With the dividend notice last month shareholders of the ANGLO AMERICAN CORPORATION OF SOUTH AFRICA were informed that the profit for 1960 is £7,497,000 and the sum available £8,159,000. Dividends equal to 9s. on the ordinary shares require £4,905,000 of this amount.

AFRICAN AND EUROPEAN INVESTMENT reports a profit of £1,249,830 for 1960, £1,045,500 of the £1,536,358 available being required for dividends, equal to 4s. 6d. on the ordinary shares.

Orange Free State.—The accounts of FREDDIES CONSOLIDATED MINES for 1960 show a loss of R.233,930, the accumulated loss now standing in the balance sheet at R.2,560,704. In the year 726,000 tons milled yielded 159,335 oz. of gold while the company's share of uranium oxide production was 215,510 lb. The report states that "in the probable event that the exploratory programme now in hand does not indicate the likelihood of any improvement in the outlook for the mine under current circumstances it will be necessary to consider at that stage the appropriate steps to be taken and to decide whether, after extracting such payable ore as may then be available, the mine should be abandoned and the assets sold or whether the mine should be placed on some form of care and maintenance basis."

Diamonds.—It is reported from Johannesburg that preparations are in hand for re-opening the Kimberley mine of DE BEERS CONSOLIDATED, closed since 1908.

In the three months to March 31 sales of diamonds effected through the Central Selling Organization totalled £24,302,351 (R.48,604,503). The figure for the whole of 1960 was £89,700,383. Shareholders of De Beers have been informed that owing to a revision of selling procedure introduced on January 1 any comparison between current and earlier sales of gem and industrial diamonds has been invalidated. In addition, automatic classification of sales into gem and industrials has become impossible and it has been decided to discontinue the practice of announcing the quarterly sales of gem and industrial stones in subdivisions.

Southern Rhodesia.—The consolidated accounts of the LONDON AND RHODESIAN MINING AND LAND COMPANY for 1960 show a profit of £65,139 and £143,347 available for appropriation. Dividends equal to 8% require £49,000.

Ghana.—At the annual meeting of the ASHANTI GOLDFIELDS CORPORATION held last month shareholders were informed that the Central Ventilation shaft was sunk 593 ft. during 1960 to its final depth of 3,558 ft. on 32 Level, connexion to the main workings of the mine being made in October, 1960. The Sub-Vertical Shaft was deepened 301 ft. from 38 to No. 41 Level and is to be sunk a further 100 ft. to No. 42 Level. At Ayeinm the extensive preparatory work was completed in October, 1960, with the commissioning of the new 450-h.p. winder. This shaft is to be deepened to No. 26 Level and sinking operations began in December, 1960. Total

development footage, including stope preparation, amounted to 57,127 ft.

Speaking at the annual meeting of KONONGO GOLD MINES last month the chairman, Mr. Robert Annan, said that the next two years should allow the present vigorous development programme to show "whether the property has a reasonable future or whether a policy of retreat should be adopted." In the meantime, Konongo's average monthly operating profit in the financial year to next September has fallen to approximately £6,000, as compared with an average of £8,000 for 1959–60.

Sierra Leone.—It is reported that, following the prospecting work carried out by the Geological Survey for the Swiss Aluminium Company, of Zurich, bauxite mining is likely to begin in the Mokanji Hills in the South-Western Province early next year. During the course of the prospecting 250 drillholes were put down and bauxite found to occur in a narrow band over about 18 miles; the thickness of the deposit varies up to a maximum of about 70 ft. and averages about 30 ft.

Nigeria.—Shareholders of NARAGUTA KARAMA AREAS were informed last month that the company's Sho areas have been sold for £6,000 cash; the titles of those areas are in course of transfer. Fuller prospecting of the pegmatite deposits on the Wamba areas is continuing.

Australia.—Speaking at the annual meeting of MARY KATHLEEN URANIUM held in Melbourne last month the chairman said that new ore reserves continue to be proved, the extension at depth, referred to last year, providing "a complex problem involving a difficult decision as to the best way to develop the mine." Whereas 1,637,000 lb. of oxide were treated in the plant, 1,470,000 lb. were added to reserves—a repetition of the experience in 1959. The chairman also said that the electronic sorter plant rejected 48,213 tons of waste material before entry to the mill and even better results are anticipated in 1961.

At the annual meeting of the RIO TINTO CO. OF AUSTRALIA last month the chairman, Mr. B. R. Pelly, said that they were aware that "the profits deriving from the existing Mary Kathleen Uranium contract for the supply of uranium oxide to the United Kingdom Atomic Energy Authority will be difficult to maintain after the expiration of the contract and they are studying closely means of diversifying into new industries. A number of promising fields are under examination.

In the three operating periods to March 13 last operations at the Mount Ida gold mine showed that 6,754 short tons of ore crushed yielded 3,003 oz. of gold for an estimated surplus of £10,405.

Philippine Islands.—It was reported last month that the Export-Import Bank of Washington had approved of a $13,000,000 loan for the construction of a complete copper treatment plant by MARINDUQUE IRON MINES AGENTS, INC. Participating in the venture are the CHEMETALS CORPORATION OF NEW YORK and SHERRITT GORDON MINES. The funds made available will be used to set up what is described as the world's first integrated copper, zinc, and ammonium sulphate plant. This will change "ores into finished copper products by chemical leaching, gaseous reduction, and newly-developed rolling methods."

Mexico.—Speaking at the annual meeting of SAN FRANCISCO MINES OF MEXICO, the results of which for the year to September 30 last were mentioned in last month's issue, the chairman, Mr. R. H. Macwilliam, announced that permission had been received from the Mexican authorities for the transfer to a wholly-owned subsidiary—CIA MINERA PLOMOSA S.A.—of all the mining titles which were acquired by San Francisco prior to 1924 and said that those titles had now been registered. All mining titles acquired subsequent to 1924 are already held by Cia Minera Plomosa S.A. Permission had also been sought for the transfer to the new company of all fixed assets and surface rights and provided such permission was received it was proposed to transfer Mexican operations to the Plomosa Company as soon as possible.

Canada.—The address of the president of the RIO TINTO MINING CO. OF CANADA made to shareholders in Toronto last month refers to the company's anxiety to diversify its interest, particularly in view of what had happened to the uranium companies at Elliot Lake. Through the exploration subsidiary, RIO TINTO CANADIAN EXPLORATION, an extensive programme in search of new economic mineral deposits was carried out during 1960 and a similarly extensive programme is planned for 1961. Some of the work is a follow-up on investigations started in the previous year.

In the 1960 season the YUKON CONSOLIDATED GOLD CORPORATION dredged 4,517,964 cu. yd. of ground and recovered

gold worth $1,994,767. Provisional figures show that the profit for the year would be $100,000.

Sweden.—It is reported from Stockholm that the LKAB Kiruna mines in Northern Sweden broke their own production record in March, achieving a total extraction of 1,210,000 tons of iron ore—the biggest output figure ever reached in one month. Of this quantity about 75% was produced underground. The previous record, 1,140,000 tons, was made in November, 1960.

United Kingdom.—Preliminary figures for 1960 issued by HALKYN DISTRICT UNITED MINES show a loss for the year of £1,523, after providing £1,000 for depreciation. After allowing £25,195 for the special interim dividend paid earlier there is a credit balance of £6,540 carried forward.

Shareholders of SOUTH CROFTY, LTD., have been informed that the profit for 1960 was £9,729, after allowing £24,404 for depreciation.

Consolidated Tin Smelters.—A notice to shareholders of Consolidated Tin Smelters last month was to the effect that the company had disposed of its interest in the HOLLANDSCHE METALLURGISCHE BEDRIJVEN, of Arnhem, Holland.

General Tin Investments, Ltd.—The accounts of General Tin Investments, Ltd., for 1960 show a consolidated net revenue of £239,887 and a total of £399,045 available. Dividends equal to 14% require £185,220 and after placing £50,000 to reserve there is a balance of £163,825 to be carried forward.

Placer Development, Ltd.—The consolidated report of Placer Development, Ltd., for the three months ended January 31, 1961, shows a profit of $904,828, bringing the nine-month total to that date up to $2,180,690, or $0·85 per share. The strike at the Bunker Hill smelter was terminated in late December, 1960, it is stated, and shipments of current lead production from the Emerald mine, near Salmo, B.C. were resumed in January, 1961. Arrangements have been made for the gradual shipment in 1961 of the lead stockpiled during the strike.

DIVIDENDS DECLARED

*Interim. †Final.

(Less Tax unless otherwise stated.)

†**African and European Investment Co.**—25 cents, payable May 12.
†**Anglo American Corporation of South Africa.**—50 cents, payable May 12.
Apex Mines.—Pref. 5½ cents, payable Apr. 28.
***Beralt Tin and Wolfram.**—1s., payable May 18.
***Blinkpoort Gold Syndicate.**—20 cents, payable May 24.
†**Burma Mines.**—1¼d., free of tax, payable May 19.
†**De Beers Consolidated Mines.**—75 cents, payable May 15.
***Falcon Mines.**—6d., payable May 9.
***Free State Geduld Mines.**—35 cents, payable May 24.
***Gopeng Consolidated.**—4½d., and 9d., both payable May 24.
***Harmony Gold Mining Co.**—14 cents, payable May 24.
***Lake View and Star.**—1s., payable May 31.
†**London and Rhodesian Mining and Land Co.**—4%, payable May 19.
***Lydenburg Platinum.**—3·5 cents, payable May 8.
***Mount Lyell Mining and Railway.**—1·2d. Aust., payable Apr. 27.
***Potgietersrust Platinum.**—3·5 cents, payable May 8.
***President Brand Gold Mining.**—25 cents, payable May 24.
***President Steyn Gold Mining.**—7·5 cents, payable May 24.
***Rustenburg Platinum Mine.**—R. 1·21, payable Apr 11.
***St. Helena Gold Mines.**—23 cents, payable May 24.
†**Selayang Tin Dredging.**—20%, payable May 31.
***Sungei Way Dredging.**—5%, payable May 1.
†**Union Corporation.**—18·5 cents, free of tax.
†**Union Minière.**—B. Francs 1,500 per full share.
***Union Platinum Mining Co.**—5·3 cents, payable May 8.
***Wankie Colliery Co.**—6d., payable May 26.
***Waterval (Rustenburg) Platinum Mining Co.**—5·8 cents, payable May 8.
***Welkom Gold Mining.**—3 cents, payable May 24.
***Western Holdings.**—45 cents, payable May 24.
***Winkelhaak Mines.**—5 cents, payable May 24.

METAL PRICES

Apr. 10.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	210	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	30	5	0
Silver		6	7⅝
Gold	12	10	7½
Wolfram (U.K.)		—	
(World)	6	0	6

Tin, Copper, Lead, Zinc } See Table, p. 240.

South African Mining in 1960

A year of recovery and consolidation is reviewed

L. A. Waspe

Introduction

In all the major sectors of the South African mining industry during 1960 influences derived from the export markets were largely the dominant considerations. Gold output and external sales reached new record levels, on which was superimposed a major burden in the earning of foreign exchange. The domestic market in base minerals and metals again expanded in the aggregate, but here again was detected the influence of export demands, particularly for such ferro-alloys as ferro-manganese and ferro-chrome, as well as iron ore and products. In many items of raw minerals direct exports reflected welcomed recoveries. Consequently, on balance widespread gains were recorded in production and especially sales of most of the major minerals and metals.

In general last year was one of recovery and consolidation for South African mining, outstanding features being few in number. In gold operations efforts appeared largely directed towards the expansion of stoping to deliver higher tonnages of ore to mill, partly to provide against an anticipated decline in uranium earnings and partly to expand output and therefore earning capacity in respect of foreign exchange. In the other divisions of mining efforts appeared largely directed towards raising output to levels more closely conforming to existing capacity rates and otherwise holding the line as far as possible.

Gold

As things were in 1960 the gold-mining industry could look forward well into the next century. It was estimated that over the next 30 years or so the average annual output would be valued at about £250,000,000. The benefits to the country of gold operations could therefore reasonably be assessed as long-term. The industry appeared to be poised for further expansion and for the planning and exploitation of new prospects and propositions, but seemed to be weighing in the economic and financial balance many militating conditions and factors which merited amelioration and which were holding up such plans and causing stagnation. The more important of these conditions and factors appeared to be relatively high levels of State claims on the industry (fiscal payments to the State averaged 9s. in the £ against 6s. in respect of other industries), rising working costs, high capitalization structures, the prevailing gold price, lengthy periods of exploration and development, an adverse financial and investment climate, partly due to economic and politico-economic and partly to essentially political conditions and shortfalls in staff categories of skilled personnel, which, if anything, will be intensified by the extension of mechanization.

Apart from the categories mentioned the availability of white personnel appeared satisfactory, a considerable improvement being recorded in recruiting learner-officials (mining). A scheme providing technical education on the mines and at technical colleges was implemented to stimulate the recruiting and training of learner-officials (mechanical and electrical engineers). Incentives were also introduced for certificated officials in all categories. Workshop production bonus and incentive schemes seemed likely to be extended further for artisan and certain operating personnel. Despite a slight fall-off in the native complement—the major gold producers averaged 376,577 against 380,473 in 1959 and 239,867 a month in 1958—all requirements remained satisfactorily supplied in 1960, especially when set against plans for extended mechanization. Generally the programme to centralize the training of personnel within the industry by the different groups was intensified and extended. In administration greater stress was placed on avoiding labour and staff wastage ; on the more appropriate and more suitable assignment of personnel to work more closely conforming to aptitudes and qualifications ; on improved training methods ; on

better apprentice training; on adequate liaison between management and training/educational institutions, and on more attractive working conditions.

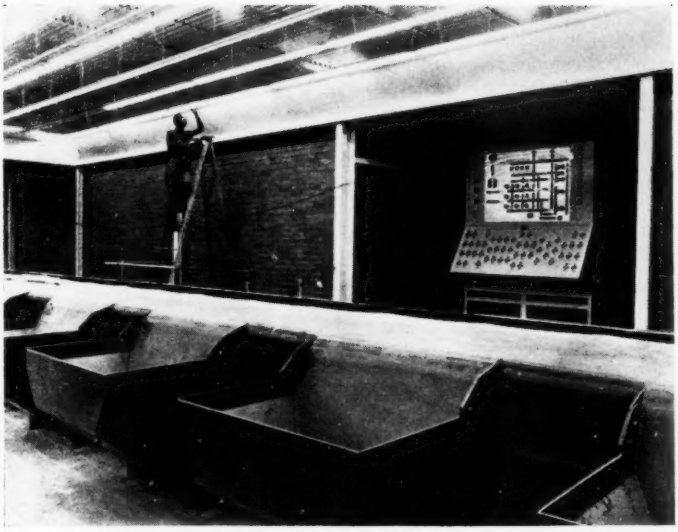
An intensive research programme was maintained by the groups themselves, the Chamber of Mines, and by institutions and organizations associated or associating themselves with the programme, supplemented by the efforts of the engineering industry. On the mines there were noted the extension of automatic or semi-automatic hoisting of rock ore, wider application of the Koepe winder (particularly for deep-level operations), installations of the Blair multi-rope multi-layer hoist at some mines, and further use of the Blair multi-rope stage hoist. Light aluminium sections were introduced in man-cages, to increase the effective carrying capactities. Shaft-sinking technique to accelerate operations and thereby shorten the pre-production period was refined further through an intensification of organizational efficiency and the use of larger-capacity more efficient units (together with extended mechanization, where possible, expecially in the mucking-lashing assemblies, where Mr. D. Bentley has played a leading role). There improvements were reflected in advancing the world shaft-sinking records to more than 1,000 ft. at both President Steyn and Hartebeestfontein. Abrasion in pumps received closer attention.

In mining practice long-wall methods of stoping were extended further, especially in the deeper levels of both Transvaal and Free State mines and particularly in high-grade sections. Peculiarly adaptable to narrow reef stoping was the development of the Blair low-head stope-scraper. In metallurgical practice automatic control systems and centralized control panels were installed in new plants. One group—Union Corporation—extended direct milling of run-of-mine ore. The Stellar automatic filter was applied to the clarification of pregnant filtrates and the separation of gold slime from barren solutions on a relatively extensive scale. In tests of the filter solution tailings values were found to be reduced from 10 to 20 times to 0·001 dwt. a ton of solution. The general accent appeared to be on continuous flow, requiring a minimum of operational administration and supervision, and on the extended use of concrete in structures to reduce structural maintenance to a minimum.

Individual Producers.—Five mines were in the developing stage, four of which reached the immediate pre-production stage last year. Western Deep Levels virtually completed its two vertical shaft systems, which will serve the shallower Ventersdorp Contact horizon, advanced the erection of the gold plant, and initiated operations for sinking the sub-vertical shafts to 9,700 ft., which shafts will serve the deeper Carbon Leader horizon. The initial milling rate, scheduled for late 1962, will be 80,000 to 96,000 tons a month, subsequently to be raised to 120,000 to 144,000—when Carbon Leader ore will be treated with ore from the shallower horizon mentioned—and ultimately to 200,000 to 240,000 tons a month. With initial milling expected to be brought forward to about mid-1962 at 50,000 tons a month Western Areas virtually completed its first shaft system in 1960 and reported satisfactory development values on both the Ventersdorp Contact and Elsburg horizons. The shaft system has an ore-to-mill hoisting capacity of 200,000 tons a month. With first milling scheduled for 1962 at initial rates of 75,000 to 90,000 tons a month, eventually to be stepped up to 150,000 to 180,000, both Bracken and Leslie mines virtually completed their first shaft systems and started erection of their gold plants. By the end of 1960 Zandpan's first shaft sinking had reached an advanced stage and a second deep-level shaft was planned. The sites of both are in the south-central section immediately north of the Vaal Reefs and Western Reefs mines.

The general picture presented by the young adolescent producers of the Transvaal and Free State was largely one of completion of the stage in which development and the establishment of ore reserves had been carried to the point at which full treatment rates could or would be reached or sustained and at which the expansion of underground operations and the planning of new shafts could be undertaken on a replacement basis—that is, to replace stoped-out areas. An exception was the Winkelhaak mine, which, still in its primary building-up stage, initiated operations to sink its third shaft system in the south-east section in a programme to raise the milling rate to the 150,000 to 180,000 tons a month range.

At Doornfontein the programme includes sinking a third shaft in the lower-grade central section and raising the gold plant capacity to the 125,000 to 150,000 tons a month range, which projected higher rate should, at least partially, offset the anticipated decline in the mill grade as operations are



Control Panel in the Sorting Section of the E.R.P.M. Mill.

extended westwards. Concomitant with opening up its higher-grade south-western section West Driefontein is to raise its milling rate to 205,000 tons a month, which will include 75,000 tons of Ventersdorp Contact ore. A second sub-vertical will be sunk in the south-western section, which shaft will provide higher-grade ore to balance lower grade from the central section (where a deep-level sub-vertical will be sunk) and from the eastern section (where a shallow-level shaft is being sunk and a deep-level sub-vertical will probably be sunk). Blyvooruitzicht was preparing to sink the final series of sub-incline shafts to serve operations down to the southern boundary.

Most of the Klerksdorp mines conform to the general picture. Western Reefs is sinking its fourth shaft to open up the northern Vaal Reef section. With its southern shaft completed the Vaal Reefs mine has entered on the stage of building up its milling rate to 125,000 to 150,000 tons a month and eventually to the 150,000 to 180,000 range. Buffelsfontein started work on its easterly twin-shaft system in a programme aiming at a 200,000 to 240,000 tons a month milling rate, to sustain which three deep-level sub-vertical shafts will be sunk. Stilfontein's programme has a projected milling rate of 180,000 to 225,000 tons a month and includes sinking a deep-level shaft. Hartebeestfontein's fourth shaft, being sunk in the south-western section, will enable the mine to raise the milling rate above 130,000 tons a month, while a fifth shaft is planned in the north-western section.

Most of the Free State mines have built up their ore reserves to satisfactory levels. The exception is Loraine, which, with the completion of its Riebeeck shaft is now in a position to do so, but the programme will probably require another shaft in or for the Riebeeck section, where Elsburg development results have been up to expectations. Free State Geduld has largely completed its initial shaft-sinking programme and much the same can be said for the other mines in the sector. Projected milling rates are : President Brand (which will eventually sink its fourth shaft system in the southern section) 150,000 to 180,000 tons a month ; President Steyn 125,000 to 150,000 tons per month ; Free State Geduld (which is sinking a main hoisting component in its south-western section and in due course will probably sink a fifth shaft system in the eastern section)125,000 to 150,000 tons per month ; Western Holdings (which is converting its northern shaft to a twin-system to increase the ventilation flow) 175,000 to 210,000 tons per month. St. Helena, which has extended ventilation capacity through its completed shaft systems will eventually sink two additional shafts in respectively the south-central and south-eastern sections. Harmony, which has completed its initial shaft-sinking programme, raised its gold plant capacity to the 200,000 to 240,000 tons per month range. Free State Saaiplaas officially commenced gold production

on January 1, 1961, at 50,000 tons per month, which will eventually be increased to 100,000 to 120,000 tons per month in a development programme that has been delayed by water-fissures and faulting and by a reef-dip flatter than expected. The main residual interest, under prevailing circumstances, in Freddies Consolidated lay in exploratory results from the testing of the Elsburg horizon in the extreme western section and in a possible deal with the Loraine company involving part of the former's property, probably including one shaft.

A consortium of major South African mining finance interests advanced negotiations successfully to take over Kennecott Copper Corporation's holdings in the Virginia and Merriespruit companies, the latter passing to the control of Rand Mines, which will co-ordinate Merriespruit development in the future more closely with operations in the neighbouring Harmony mine.

Exploration.—A widespread programme of gold exploration was continued in the Transvaal and Free State, notwithstanding the abandonment of considerable areas. Results from the Western Holdings area, immediately south of the major Klerksdorp mines, indicated a probable lease area of economic grade, in which area the Free State Development company may be a participant among others. Other prospecting areas are west of Free State Geduld and Western Holdings (substantial participants); in the Kroonstad area (Johannesburg Consolidated Investment and others), and south-eastwards and eastwards from Bethaville (Anglo-Transvaal and associates).

In the Transvaal Western Areas No. 2 Prospect was formed by Johannesburg Consolidated Investment and associates in the vicinity of the Western Areas mine, while to the west drilling yielded satisfactory Ventersdorp Contact and Elsburg Reef values near the Libanon mine but at depths of nearly 9,000 ft. Exploration in the Ventersdorp-Coligny sector (Anglo American, its associates, and others) was scheduled to be completed by the end of 1960. To the south, in the Klerksdorp area—mainly east and particularly west of the town—extensive options were taken up and drilling was initiated (Gold Fields and associates; Anglo American and associates; Johannesburg Consolidated Investment and associates; Anglo-Transvaal and associates, etc.). In the Kinross area, Eastern Transvaal, Union Corporation and associates extended exploration to the north-west, while Johannesburg Consolidated Investment took up extensive options to the north of the mines in the sector. Other prospecting areas formed and/or explored are situated in the Potchefstroom area; in the Delmas/Bronkhorstspruit areas (Anglo-Transvaal and associates); in the Brits/Rustenburg area (Gold Fields and associates), and south of the Old Rand, eastwards from the Western Areas mine (General Mining and associates, and others).

Uranium

New arrangements were initiated and concluded for a contractual period extended to 1970 from 1966. Over the extended period, 1961–70, 22,397 tons will be supplied to the Combined Development Agency (United States and United Kingdom) in the first six years and 5,953 tons to the United Kingdom in the following four years, excluding the Harmony contract to supply the United Kingdom authorities with an additional 1,127 tons in varying annual tonnages in the 1961–70 period. Sales will be at fixed prices differing little from those under the superseded contracts. Inter-company arrangements have been made for the cession of sales quotas by high-cost to low-cost producers involving royalty payments to the cessors. Certain mines will suspend operations on the expiration of their current contracts; all but one of the companies, largely dependent on uranium revenue, will suspend completely either immediately or soon or switch to gold production. Only West Rand Consolidated, Buffelsfontein, Vaal Reefs-Western Reefs in a joint scheme, Hartebeestfontein, and Harmony will be contractual uranium producers from 1967–70, compared with 27 at the end of 1960. The new arrangements have not changed the total tonnages to be sold from 1961 onwards, but have merely extended the period of production and sales.

In 1960 the intensive research programme to render more competitive uranium output was advanced further. Process modifications, to enhance extraction, were effected and included application of the high-temperature ferric leach; uranium leaching before gold extraction instead of *vice versa*, and studies into the use of bacteria to improve the extraction of uranium. A joint uranium refining pilot plant, with an output capacity of 100 tons of uranium metal a year, has been erected.

Other Metals and Minerals

Diamonds.—The decision was taken by De Beers Consolidated Mines and associates to establish at Springs, Transvaal, a diamond grit synthesis plant. In the Cape Province no outstanding new developments were recorded. Generally output of quality gem diamonds remained below demand levels. In the Annexe Kleinzee area, Namaqualand, extensions of known payable deposits were located.

Platinum.—While sales in 1960 were maintained, production was stepped up to replenish depleted stocks. Statistics are not available but average prices realized were higher than in 1959. The only producer, Rustenburg Platinum Mines, Western Transvaal, acquired additional mineral rights in the Lydenburg area and of these ceded the chromite rights to Johannesburg Consolidated Investment.

Manganese.—In the Kuruman-Hay area two new mines were developed for production. In the mining zone rail facilities were extended and these will serve both manganese and iron-ore producers.

Chromite.—Improved marketing conditions were noted but there was no incentive to extend workings or establish new mines. Activity remained generally restrained. Domestic chrome chemical production has been expanded and output of ferro-chrome, as in the case of ferro-manganese, has been expanded.

Iron Ore.—Output and sales expanded mainly on export influences. New production was recorded in the Postmasburg-Sishen area of the Northern Cape. The country's major producer, S.A. Iron and Steel Industrial Corporation, has embarked on a major expansion programme over the next 11 to 12 years, which will mean doubling output capacity at its Thabazimbi (West Transvaal) and Sishen (Northern Cape) mines. An extensive modernization and mechanization programme is proceeding at the former.

Asbestos.—Sales from stocks to some extent accounted for the improved returns. While no new mines were reported as having been established many producers extended mechanization and otherwise improved production facilities, mainly to produce more competitive grades. In some cases asbestos rights or holdings were extended.

Phosphate.—Relatively active conditions prevailed in this field. At Phalaborwa, Northern Transvaal, the flotation plant was expanded and additional quarries established. To facilitate beneficiation tests exploratory development of the lower-grade ore-body was initiated. The major producer in the Cape initiated study into the beneficiation of low-grade ore and extended intensive exploration for new deposits, in which was included the Saldanha Bay area.

Copper.—While productive activity remained restrained interest in the Northern Transvaal deposits took the form of exploratory development at Phalaborwa to test the ore-body and supply a pilot concentrating (flotation) plant. Copper-zinc ore from the Letaba deposits was successfully treated in a pilot electrolytic plant.

Tin.—The outstanding development was the unexpected discovery by the Zaaiplaats Tin company of extensive high-grade cassiterite lodes in exploratory development. Generally production facilities were placed on sounder bases both underground and in treatment plants.

Oil-from-Coal and Oil-from-Torbanite.—The first stage consolidation and expansion programme of the major Northern Free State oil-from-coal project from 35,000,000 to 40,000,000 gallons a year was completed. A second-stage expansion programme to double that output and that of chemical by-products over the next seven to eight years at a cost of about £30,000,000—to be appropriated from earnings—was initiated. This second-stage programme stemmed from (*a*) the need to boost net profits to give an adequate yield on the capital invested; (*b*) from the loss of supplies from the S.A. Torbanite Mining and Refining Co.; (*c*) the consequent shortfall in the present supply capacity below the pump capacity already installed at distributing stations. The S.A. Torbanite company exhausted its torbanite deposits but successfully concluded negotiations with major oil importers to refine imported oil in its modified, modernized, and expanded plant and to market the products through those major companies instead of, as previously, through the oil-from-coal project, S.A. Coal, Oil, and Gas Corporation.

Coal.—Generally well supplied with labour, apart from shortfalls in the skilled artisan categories, the industry tended to extend mechanization further. Domestic marketing remained steady, export influences mainly accounting for the improved returns.

Miscellaneous

A new major ammonia producing plant, consuming low-grade Transvaal coal, was commissioned near Johannesburg by African Explosives and Chemical Industries, which—already producing gelignite, igniter cord, and detonators—started erection of plant for manufacturing safety fuse.

The Anglo American Corporation assumed control of Minerals Engineering of S.A., Ltd., producing vanadium pentoxide at its Witbank, Eastern Transvaal, plant from Transvaal ore.

A further expansion of ferro-alloy production was projected at works in the Transvaal and Natal.

A decision to set up plant to produce graphite electrodes from domestic raw materials was jointly taken by African Metals Corporation and the Siemans-Plania organization.

Extensive deposits of gypsum were located in the Western Transvaal.

Plans were formulated to expand further output capacity in lime and limestone works of the Transvaal and Northern Cape.

The outlook and outlets for titanium concentrates from the Natal South Coast deposits of Umgababa Minerals were improved through the start of erecting a plant in the same area to produce up to 10,000 tons a year of titanium products under the joint auspicies of African Explosives and British Titan Products.

Railways

Last year saw the stage reached where all traffic offered could be expeditiously handled by the South African Railways. However, expansion and development was to be advanced further to provide against future traffic growth. Road transport of coal was suspended from the beginning of 1960. Facilities for shipping greater tonnages of pig-iron exports were planned for Durban. Later reports showed that deferred plans to mechanize ore-loading facilities at Port Elizabeth were to be implemented over the next year or so.

Driving and Lining Tunnels in London Clay

An account of work on a one-mile length of twin tunnels for London Transport.

Introduction

The object of driving two experimental tunnels in London Clay in the Finsbury Park area of London is to give full-scale experience of new methods of tunnel construction in readiness for the Victoria line and other future tube lines. The experimental length is on the alignment of the Victoria line and will be incorporated into it when authority to build the line is given. It is thought that the new methods could save considerably on the cost of the 11½-mile line.

It is 21 years since a new section of tube railway was built by London Transport and 54 years since the last tube railway across central London was built. In the interim period new knowledge of the stresses and strains in tube tunnels has been obtained by special tests, including the removal of original tube linings, and as a result new designs of linings have been evolved entailing new methods of tunnelling. London Transport considered it essential that it should test such methods so that the quickest and most economical form of tube tunnelling available could be used where appropriate. Contracts were therefore placed early last year for the construction of the two experimental lengths of twin tunnel, one running from Finsbury Park to Manor House and the other from Netherton Road (Tottenham) to Manor House, where the two lengths of tunnel meet. The total length of twin tunnel involved is about one mile and the cost will be about £1,000,000.

The Finsbury Park–Manor House section is being lined with concrete block segments of

Driving Position in the Digger Shield.

a new pattern and the Netherton Road–Manor House section uses a new type of flexible jointed cast-iron lining without bolts and with much shallower flanges than those of conventional linings. Previously tube tunnels have been lined with bolted cast-iron segments built inside a shield and with cement grout forced into the space left as the shield moves on between the outside of the segments and the surrounding ground. The tunnels are being bored by a rotary type of shield called a " drum digger " which can work much faster than any previous type of shield used for tube railway construction in London and which provides for conveyors to remove the spoil.

Using the cast-iron lining method, the contractors for the eastern half of the tunnel, Edmund Nuttall Sons and Co., (London), Ltd., have just completed the driving of a 934-ft. length of tube tunnel, including the excavation and lining, in two weeks.

One drive of each type of tunnel has now reached Manor House where a cross-passage has been built connecting the two. This also enables the engineers to close their survey traverse at tunnel level and thus obtain very accurate junctions between the second and first drives. Work is now complete on the second drive from the Netherton Road end and the drum digger has started on the second drive from the Finsbury Park site.

Access Shafts

The Netherton Road shaft, 25 ft. in diameter, is 60 ft. deep. This shaft is to be a permanent part of the Victoria line and will be used for ventilation and emergency stairs. From its foot an access tunnel runs a short distance to the line of the running tunnels, where chambers large enough to permit the assembly of the " drum digger " rotary shields have been excavated by pneumatic spades and lined with bolted cast-iron segments. At this site excavated spoil is brought to the surface by a crane which lifts the $1\frac{1}{4}$-cu. yd. skips off the 2-ft. gauge bogies which have brought the spoil in trains hauled by battery locomotives along the completed section of the tunnels. The skips are loaded by conveyor from the rotary cutters at the face and are emptied on to the ground, the spoil being loaded into lorries by a 1-cu. yd. mobile shovel. A small electrically-operated traverser is used to manœuvre the skips at the bottom of the shaft.

At the Finsbury Park working site the shaft is 15 ft. in diameter and 60 ft. deep. As at the other site, an access tunnel leads from its foot to the line of the running tunnels and there are two shield assembly chambers. The running tunnels are on a gradient of 1 in 47 down and the loaded ¾-cu. yd. skips are hauled by an electric winch sited in the shield assembly chamber. The skips tip the spoil on to a belt-conveyor in the access tunnel and the conveyor delivers the spoil to the foot of the shaft where it is hoisted to the surface by a vertical bucket elevator. The buckets are warmed by hot air to prevent the clay from sticking to the metal. Originally the clay was carried to an elevated hopper under which lorries could be loaded by gravity, but it has now been found better to bring the spoil to ground level and use a 1-cu. yd. mobile shovel for loading.

Tunnelling Equipment

The drum digger type of shield, developed by Kinnear Moodie and Co., Ltd., and Arthur Foster Constructional Engineers, Ltd., has been used previously on the tunnelling work for the Metropolitan Water Board's Thames to Lee Valley water tunnel. The experimental railway tunnels are of much greater size than the water tunnel, so that the drum digger shields are on a larger scale.

The drum digger for the concrete-lined tunnels has an external diameter of 14 ft. and that for the cast-iron-lined tunnels 13 ft. 1 in. The digger consists essentially of two drums. That for the 14-ft. diameter tunnels has an outer drum of 14 ft. external diameter and 9 ft. in length and the leading end is bevelled to form a cutting edge. Within the main drum is a 7 ft. 6 in. diameter rotating drum 5 ft. 6 in. in length carried on two roller races and provided with a thrust ring to take the axial load from the rotating cutters. The cutting teeth themselves are mounted on six arms at the front of the shield, each carrying eight removable teeth. They are mounted at the outer edge of the inner, rotating, drum, so that they cut the area in front of the space between inner and outer drums. The area in front of the inner drum is cut by teeth mounted on a removable arm across the diameter of the inner drum. The teeth may be replaced after hand-mining a small cavity in front of the arms. The inner drum and the cutting teeth with it can be turned at speeds of up to 4 r.p.m. by six hydraulic motors driving through gear-boxes. Pinions at the driving ends of the gear-boxes engage the teeth of a large gear ring bolted to the rotating section of the drum digger. The hydraulic motors are controlled by a valve within the shield.

The forward movement of the shield is given by 14 hydraulic rams arranged at equal spacing round the periphery of the shield and pushing against the last completed tunnel ring. These rams, which have a stroke of 2 ft. 8 in. and operate at a working pressure

Loaded Cars Leaving the Tunnel Face.

Fitting the Cast-Iron Lining Segments.

of about 2,000 lb. per sq. in., are individually controlled by an operator standing within the shield casing but behind the rotating inner drum.

The ram operator is provided with sighting guides which show him whether the shield is on the correct line and level and he can apply or reduce pressure to any of the rams to correct any tendency to deviate to the right or left or up or down. The sighting devices used on the two shields employed in the experimental tunnel are different, the more elaborate being arranged so that the ram operator can sight the image of a cross of light on a graduated mirror and obtain a direct indication of any deviation from true line or level. The source of light is a lamp placed further back along the tunnel from which a beam passes through two cruciform slits in markers fixed to the roof of the tunnel and placed precisely in the correct position by the use of surveying instruments. When driving a curved length of tunnel the mirror sighting device is adjusted against a scale after each ring of lining is erected to keep the shield on the proper alignment.

The clay is cut by the rotating teeth and guided by scoops and paddles into a hopper within the shield where it drops on to the end of an inclined electrically-driven belt-conveyor. This discharges on to the main horizontal belt-conveyor which carries the excavated clay back along a staging, from which it is discharged into the skips on 2-ft. gauge track on each side of the horizontal conveyor.

Under the conveyor staging is a 200-h.p. electric motor driving pumps to provide hydraulic power for the shield motors. A separate 12½-h.p. electric motor supplies hydraulic power for the rams. At the sides of the conveyor-belt at the shield end are electric hoists for handling the tunnel lining segments. To the rear of the conveyor and the hydraulic power unit the tracks on each side of the conveyor converge into one and pass down a short ramp to join the main tunnel track.

The whole of this apparatus from immediately behind the shield to the rail ramp at the rear is mounted on an articulated trailing platform attached to the rear of the shield and drawn forward as the shield advances. When the rams have pushed the shield forward the width of a ring of tunnel lining—*i.e.*, 2 ft.—they are retracted. A ring is then built in the space between the last completed ring and the rear of the shield. When this

has been completed the whole cycle recommences, the rams pushing against the newly-installed ring.

Considerable heat is generated at the working face and the oil in the hydraulic system is cooled by a heat exchanger. The cooling water is fed to the exchanger by piping from the shaft and on the return circuit is taken to the head of the shaft and passed through a cooler before being returned to the tunnel. The pipes of the cooling water circuit, like the power leads to the working face, have to be extended from time to time as work progresses.

The drum digger is capable in good conditions of advancing more than 60 ft. a day, working three 8-hr. shifts over long periods; the maximum length driven to date in one 24-hr. period is 88 ft.

Apart from the smaller external diameter of 13 ft. 1 in. the drum digger used for the cast-iron-lined tunnels is similar in construction and operation.

Tunnel Linings

The lining of the tunnels built from the Netherton Road site is of unbolted flexible-jointed cast-iron segments. There are six segments each 1 in. in thickness to every 2 ft. tunnel ring. One end of each segment is concave and the other convex, so that the ends of the segments form knuckle joints each fitting into another. The segments are put into place in the space left behind the shield when the rams are withdrawn, the two forming the invert being laid first, then the side segments. Finally the segments forming the roof are manhandled into place and held by " needles " mounted at the rear of the shield. The two segments forming the floor of the tunnel are cast with small recesses at their upper ends and, when the segments have all been erected, hydraulic jacks are fitted into these recesses and a force of 15 tons per jack is applied to the ring segments, expanding them against the clay outside. This expansion creates a small gap between the segments forming the sides and those forming the floor or invert of the tunnel. Into each of these gaps are placed first two cast-iron knuckle-pieces shaped to conform to the contour of the segments below and then two pairs of cast-iron taper packings which hold the whole ring firmly in place when the pressure of the jacks is released.

The segments have shallow interior ribs which are enlarged to form perforated lugs at regular spacing round the periphery of the ring for handling purposes and to provide for the fixing of the railway equipment in due course—*e.g.*, signal equipment and cable brackets, noise reduction screens, and tunnel lighting. The internal diameter of this type of lining from rib surface to rib surface is 12 ft. 8 in. This is somewhat more than is absolutely necessary, but the external diameter is the same as that required for the conventional cast-iron lining which may have to be used on certain lengths where there are junctions, cross-passages, or other special features. The conventional lining, of 12 ft. internal diameter, has deep recesses which can be used to accommodate comparatively bulky signal equipment and other apparatus. The recesses in the flexible-jointed cast-iron lining are shallow, so that all equipment necessarily stands out from the inner surface of the tunnel lining.

The pre-cast concrete lining of the other half of the tunnels is also of a new type. The tunnel itself is driven by the larger of the two drum diggers to give space for a tube of 12 ft. 6 in. internal diameter with a lining of pre-cast concrete segments, of which various thicknesses—from 4½ in. to 9 in.—have been tested.

Each tunnel ring is made up of 14 identical segments having one cross-joint face convex and the other concave, so that they fit together with knuckle-joints similar to those used for the iron segments. When the 14 segments are assembled a gap of about 7 in. remains at the top. This gap is filled by a pair of reinforced-concrete folding wedges having plane contact faces and concave and convex faces respectively in contact with the segments on each side. The wedge with the wide end nearer to the shield is driven home by a pair of small hydraulic rams while the other wedge is held in position. These two wedges held the whole ring firmly in place. The concrete segments are cast with four holes equally spaced round the interior circumference. These are used for handling in the tunnel and will also be used with expanding bolts for fixing tunnel equipment, serving the same purpose as the ribs of the cast-iron segments. The concrete segments are handled by hoists at the working face, an expanding bolt placed in one of the holes being used to lift them. They are lifted into their correct positions by a manipulator arm mounted at the rear of the shield and held in place by pull-out " needles " until the wedges are driven into position.

No grouting is used with either of the tunnel linings.

An Open-Cast Lignite Mine in France

J. Grindrod

A lignite deposit in the Landes Forest has been developed for electricity generation

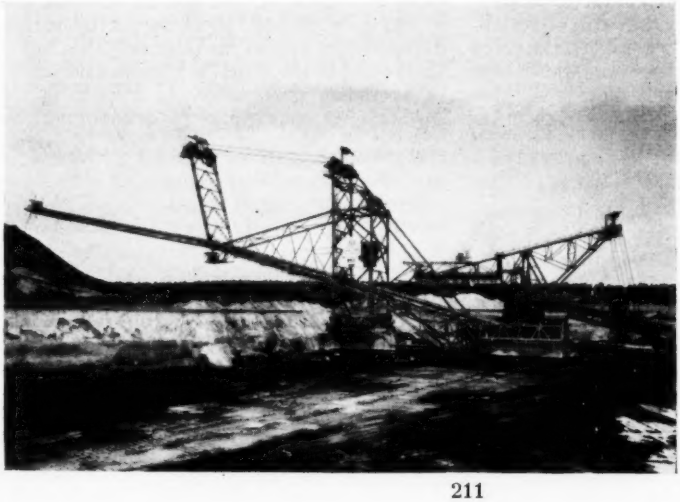
In order to provide low-cost fuel for a new thermal electricity generating station of Electricité de France at Arjuzanx, in the Landes Forest, about 100 km. south of Bordeaux, an open-cast mine is being developed which is expected to yield initially some 32,000,000 tonnes of lignite and more later as the mine is developed. The deposits in all consist of two beds of lignite known as the Beylongue and Arjuzanx deposits, the latter lying to the north of the other.

Before the production of electricity was nationalized in France the Société Minière et Electrique des Landes had, in 1929 and 1930, obtained two concessions covering the deposits and later Electricité de France continued the investigations begun by the previous holders of the concession. This was especially in respect of the northern half of the deposits where exploitation appeared to be the most feasible and economic. This northern half is estimated to contain reserves of some 70,000,000 tonnes of fuel or sufficient to supply a 200,000 kW power station for 30 years.

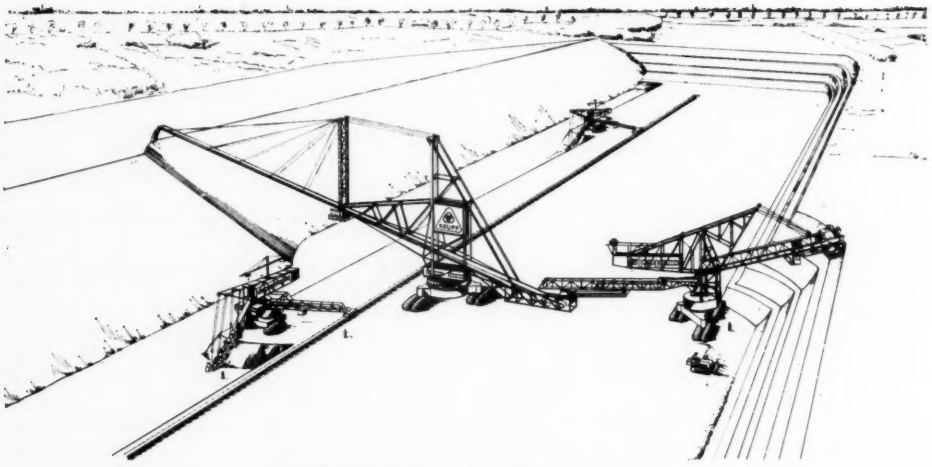
Within the limits of exploitation currently envisaged the Arjuzanx deposit contains about 40,000,000 cu. m. of lignite, or about 44,000,000 tonnes, in beds 2 m. to 6 m. thick (average 3·9 m.) all of which lie beneath overburden varying in thickness from 16 m. to 34 m. To the north of the main prospective field there is a further area of about 2 km.^{2} from which it is thought about 9,000,000 tonnes of lignite could be extracted. The bed with the most favourable recovery co-efficient lies in the south-western quarter of the Arjuzanx zone.

Only the northern part of the Beylongue deposit is at present earmarked for exploitation. This section contains about 16,500,000 cu. m. of exploitable lignite, or about 18,000,000 tonnes. The thickness of this bed varies between 1·70 m. and 6 m. (3·44 m. average) while the overburden here has a thickness of between 6 m. and 35 m.

Following further investigation it was decided in 1956 to open up an initial section of a lignite open-cast mine representing about 32,000,000 tonnes and to construct a 120,000-kW steam power station which could use the lignite as fuel. This initial cut would include



Bucket-Wheel Excavator at Work.

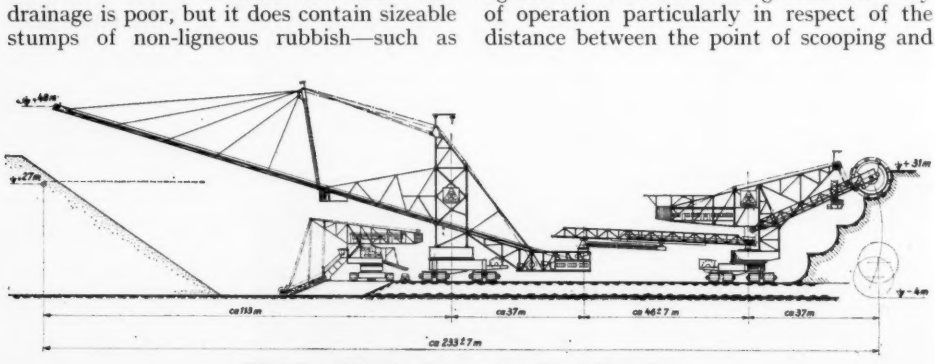


Scheme of Operation at Arjuzanx.

the south-western quarter of the Arjuzanx bed, expected to yield 14,000,000 tonnes, and the northern portion of the Beylongue bed, involving about 18,000,000 tonnes. The mine is to be worked fanwise around a fixed point and the northern part of the Beylongue bed will be the first to be exploited. This section has been divided into 16 cuts each of which represents rather more than 1,000,000 tonnes of lignite or one year's working. Similarly for subsequent working the Arjuzanx deposit has been divided into 14 cuts also of about 1,000,000 tonnes of lignite each. The thickness of the overburden in this first section of the mine to be developed never exceeds 28 m. and this consists in the main of a lower stratum of yellow or blue clay 0 m. to 25 m. thick overlain by sand, more or less clayey, to a thickness of 0 m. to 27 m. It contains few stones and drainage is poor, but it does contain sizeable stumps of non-ligneous rubbish—such as fossil-wood—which not only complicate excavation but make necessary much larger crushers of specialized construction at the power plant.

Included in the machinery required for this open-cast lignite mine are excavators for the overburden and lignite and means of transporting the lignite within and away from the mine to the power station, together with bulldozers, equipment for servicing and moving the conveyor-belts, mechanical shovels, and pumps for dealing with water accumulating in the mine.

The bucket-wheel type of excavator was chosen in preference to drag-lines for the overburden because it was considered that this would give greater precision of operation, expecially in view of the relatively thin bed of lignite and at the same time greater flexibility of operation particularly in respect of the distance between the point of scooping and



Wheel and Bucket Excavators Work Together.

Overburden Discharge.

the point of delivery. The bucket wheel would also exert constant pressure on the underlying earth and would involve less risk of becoming bogged down.

Supplied by Krupps, of Rheinhausen, West Germany, together with the excavator for the lignite and the lignite conveyor-belts, the bucket-wheel excavator for the overburden consists of the electrically-driven bucket wheel proper and conveyor-belt discharge equipment which operates through the intermediary of a flexible bridge taking the spoil from the bucket wheel and passing it forward to the discharge line. The driving motors are fed by three-phase, 5,500-V. current.

The bucket wheel can operate at four different speeds according to the nature of the material to be handled and other conditions obtaining and the buckets are fitted with cutters of very hard steel for dealing with the stumps of fossil wood. The boom at the end of which the wheel is located can be raised or lowered as required by means of a winch, while radial orientation is achieved through a turntable, the whole machine being mounted on caterpillar tracks.

Capable of dealing with a maximum overburden thickness of 31 m. (though the actual overburden thickness here does not exceed 28 m.) the bucket wheel is 11 m. in diameter and can take scoops up to 3·60 m. in depth below the operating level of the ground. Maximum throughput is 2,530 m.^{3}/hr. The machine can work on gradients up to 1 in 25 and its tracks exert a pressure of about 1 kg./cm.^{2} on the ground underneath them. It has a minimum turning radius of 50 m. and boom length of 38 m. Its trough-type conveyor-belts 1·8 m. in width operate at speeds of 2·8 and 3 m./s., giving a maximum possible carrying capacity of 3,150 m.^{3}/hr. The entire machine in operation weighs 1,400 tonnes and it uses 1,237 kW of power.

The spoil disposal machine has a boom 110 m. in length and the height of its point of discharge can be varied between 21 m. and 47 m. It also exerts a pressure of 1 kg./cm.^{2} on the ground through its caterpillar tracks and can work on gradients of up to 1/25. It has a minimum turning radius of 100 m., a total weight of 1,400 tonnes, and uses power to the extent of 1,226 kW. Also of trough type its conveyor-belts are 1·4 m. in width and operate at a speed of 4 m./s. to give a maximum throughput of 3,150 m.^{3}/hr.

Reckoning the co-efficient of spoil bulk increase as 1·18, the height of the heap of overburden spoil thrown out by the bucket wheel excavator would be 33 m. for an overburden thickness of 28 m. In the case of sand the horizontal distance between point of discharge and the toe of the heap would be 57 m., but this would be reduced to 53 m. with a spoil of variable content and containing some clay. The wheel cuts at an approximate angle of 45° and the distance between the toe of the overburden face and the track of the machine reduces to a minimum of 10 m. when the wheel is working on the top layer of overburden. The axis-to-axis distance between

Chain Excavator Winning Lignite.

the wheel and the discharge equipment can be varied from 76 m. to 90 m. by adjusting the intermediary bridge.

The bucket wheel removing the overburden will be in continuous operation day and night, but the motors will be stopped each year for a maximum period of two months for examination. This overhaul period will be coincident with that at the power station during which time electricity generation will be reduced.

For removal of the lignite two 400 tonne/hr. endless bucket chain excavators have been chosen. These will give a constant throughput whatever the thickness of the lignite bed to be worked and deal easily and effectively with the non-ligneous rubbish. By varying the gradient of the chains the buckets can always work to capacity. To provide greater flexibility two machines rather than one were decided upon since it would then be possible for one machine to work two shifts, while the other was being overhauled or repaired. As well as being used for the excavation of lignite the machines will be capable of being used to expose the fuel in unusual places where complete removal of the overburden has not been possible by the bucket wheel. In such latter operations the machines would dispose of mounds of material and to this end would be capable of working to a height of 11 m. The maximum operating depth when excavating is 10 m. Both the machines are operated electrically and incorporate belt-conveyors 1·2 m. wide running at 2 m./s. and yielding a maximum capacity of 750 m.^{3}/hr.

Under normal operation the two machines will be able, during one eight-hour shift, to supply the daily needs of the power station and six days' lignite extraction at this rate will be sufficient to keep the station going the full week. Annual consumption will be about 1,000,000 tonnes, for which some 7,200,000 m.^{3} of overburden must be removed. To cover various exigencies and to permit the drying out of the lignite after exposure, but before extraction, it is planned to have, on average, a margin of about 200,000 tonnes of usable lignite *in situ* in advance of requirements. This margin of 200,000 tonnes influences the maximum width of exposed lignite for the least possible length of such a band that can be allowed under the varying conditions of the deposits and this width is one of the factors determining the length of the boom of the spoil discharge machine. This has, in fact, been fixed at 50 m. for the Beylongue-Nord mine and at 60 m. for the Arjuzanx mine.

After excavation the lignite is fed on to one of three 500-m. long adjustable mine conveyor-belts, supplemented by a 500-m. long extension belt by means of which the conveyor length can be increased as required by the distance from the cut. These mine belts, in turn, feed two fixed conveyor-belts, each 400 m. long which deliver to the power station. The conveyors have a belt width of 1 m., a speed of 4 m./s., and a maximum handling capacity of 950 tonne/hr. Two specially-equipped tractors are used for servicing and moving the belts. One tractor is mounted on caterpillar tracks and the other on rubber tyres.

Bulldozers are used for clearing away stumps and roots of pine trees left in the upper layer of the soil and for dealing with the fossil material and other rubbish still remaining in the top of the lignite bed. The dozers are hydraulically operated and of 200 h.p. each. Mechanical shovels are also used in the mine for clearing road and water ways, etc. One is diesel driven with a bucket capacity of 600 litres ; the other is electrically driven with a 2 m.³ shovel.

According to the exploratory drilling the floor of the new French lignite mine will have two deep recesses into which seepage water is likely to drain. To deal with this water two groups of centrifugal horizontal axis pumps will be installed, each group comprising three (including one standby) of 300 m.³/hr. capacity and two (also including one standby) of 150 m.³/hr. capacity. These should be capable of dealing with the severest influx of water and prevent flooding of the mine. A strainer incorporated in the aspiration pipe will reduce to a minimum the quantity of sand and rubbish taken in by the pumps. In addition to the main groups of pumps two groups of submersible pumps, each of 40 m.³/hr. capacity will be available for drying out isolated points on the floor of the mine.

The mechanical shovels were supplied by Sté. Anonyme Nordest, the tractors and bulldozers by Sté. Anonyme Noralpe, and the pumping equipment by Sté. Anonyme des Pompes Ledoux.

Although, by the use of lignite, a lower cost per unit is expected than for any other type of installation this fuel nevertheless involves certain limitations or differences if compared with coke. For instance, the boilers are of very much larger and heavier type for an equivalent power, since the calorific value of the lignite is very low and this entails the erection of much taller buildings. Much larger crushers of special construction for breaking up the non-ligneous rubbish that occurs with the lignite are also required as well as producer-gas fire-boxes at the bottom of the combustion chambers.

The electricity generating plant at Arjuzanx at present includes two 60,000-kVA. generating sets supplied with steam from two boilers of 550,000 lb./hr. steam output.

The writer is indebted to Electricité de France for material from which this article has been prepared.

Columbium, Vanadium, and Tantalum Base Alloys

A major producer of columbium, tantalum, and vanadium metals—the Union Carbide International Company in America—is conducting research into a number of alloys using these metals as base. Developed by the company's Metal Research Laboratories to improve the oxidation resistance of columbium to meet space-age and nuclear requirements, the family of columbium-base alloys contain tungsten and titanium as well as aluminium and vanadium. The former group combine oxidation resistance to 2,550° F. (1,399° C.) with good mechanical properties, while those of the latter group permit a hundredfold reduction in the oxidation rate of pure columbium, at the same time retaining its inherent low-neutron cross-section and improving its mechanical properties.

Of the alloys developed in the studies by the laboratories several have been produced in experimental quantities. These include Cb7 (65 Cb, 7 Ti, 28W), Cb 84 (70 Cb, 7 Ti, 20W, 3Mo) and Cb 16 (65 Cb, 10 Ti, 20W, 3 V). Alloys with a low thermal neutron capture cross-section include Cb 22 (94 Cb, 3 Al, 3V) and Cb 24 (87 Cb, 7Ti, 3 Al, 3V).

The maximum oxidation resistance in columbium-tungsten-titanium alloys was obtained through a compositional range of 5%–15% titanium by weight and in excess of 15% tungsten by weight. Although the oxidation rate of these alloys is reduced one-hundredfold in comparison with pure columbium at temperatures above 2,200° F. (1,204° C.), they are sensitive to oxygen contamination. The oxidation resistance is sufficient, however, to allow short-time service in air at high temperatures provided that structural ductility after service is not important. The ultimate tensile strength of these alloys is in excess of 40,000 lb. p.s.i. at 2,200° F. (1,204° C.). Zirconium added to the alloys improved high-temperature strength, but reduced oxidation resistance. Molybdenum and vanadium reduced surface oxygen embrittlement, but limited the temperature range in which the alloys resisted oxidation.

In respect of the columbium-aluminium-

vanadium alloys it was found that, by adding small amounts of aluminium and vanadium to columbium, oxidation resistance was improved by stabilizing a protective layer of columbium oxide. As little as 3% each of the two elements produced a 50-fold to 100-fold improvement in the temperature range of 1,500° F. to 2,200° F. Additions of titanium gave further improvement but lowered the strength, while zirconium additions had the opposite effect. Titanium additions had an adverse effect on stress rupture properties. The columbium-aluminium-vanadium alloys had good resistance to oxygen contamination of the surface metal.

Vanadium-base alloys containing 20% to 50% columbium display good high-temperature strength, good corrosion resistance in both oxidizing and reducing environments, and can be fabricated by conventional hot-working techniques in air.

The study of this group of alloys was undertaken in view of the high melting point and low density of vanadium which suggested the use of this metal for high-temperature applications where good strength-to-weight ratio is required. Also possessing good liquid metal corrosion resistance and the characteristic that all its short-lived isotopes decay without emitting excessively strong decay products, vanadium is often looked upon as a promising structural material for nuclear applications.

Since, however, of all the refractory metals, pure vanadium is probably the least resistant to oxidation and aqueous corrosion and does not have the high-temperature strength that its high melting point would imply, the hot-working of this metal is impracticable and its use limited in chemical environments, making some alloying necessary to improve its usefulness.

In studying the behaviour of a family of alloys based on a columbium-vanadium system containing 20% to 50% of columbium by weight, Dr. Wlodek, of Union Carbide, found that, in the warm-worked condition, vanadium-columbium alloys have ultimate tensile strengths of 12,000 p.s.i. to 35,000 p.s.i. over the temperature range of 700° C. to 1,000° C. and stress-rupture properties at 700° C., corresponding to 100-hour life at stresses in excess of 100,000 p.s.i. On samples which had been warm-worked and stress-relieved, the tensile strength increased to 70,000 p.s.i. at 1,000° C. and to 40,000 p.s.i. at 1,200° C. Strain-rate sensitivity can be improved at the expense of strength by titanium additions. Both aqueous corrosion resistance and oxidation resistance of the alloys were also considerably higher than those of pure vanadium. Maximum oxidation resistance was obtained by adding titanium and aluminium.

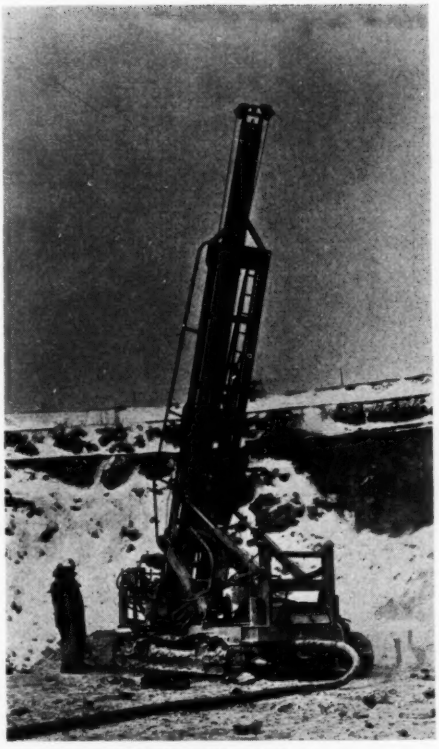
Also being undertaken at Union Carbide in co-operation with the U.S. Air Force is a programme to accumulate background information on refractory metals for the development of a columbium-tungsten-tantalum alloy applicable at temperatures up to 3,500° F. This programme will deal with the effect of interstitial impurity elements on mechanical properties of refractory metals as a class, high-temperature strengthening, and oxidation behaviour in the temperature range of 2,000° F. to 3,000° F. Particular attention will be paid to columbium- and tantalum-base alloys which show maximum oxidation resistance.

Long Holes for Huge Blast

A note on a recent clearing operation in a Quebec open-pit

Hugh G. Jarman

To put in a series of holes nearly 150-ft. deep and to load them the full length before blasting is a notable occurrence, even for the mining industry. This is what has happened at the Jeffery mine of the Johns-Mansville Asbestos Corporation, at Asbestos, Quebec.



Mobile Drill at Work.

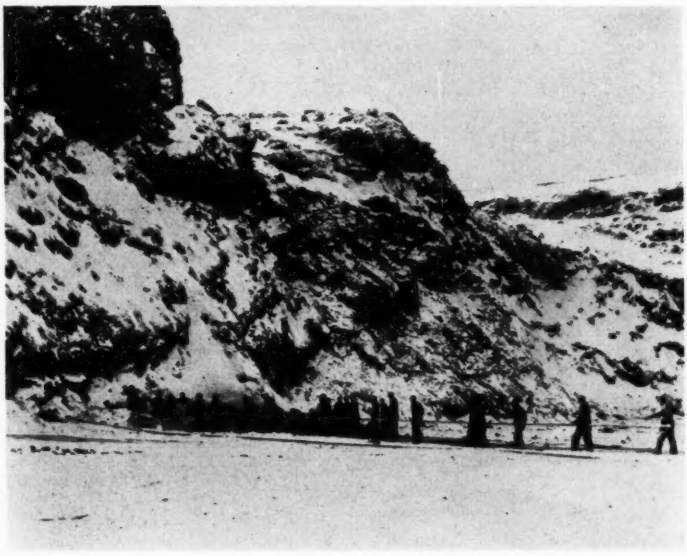
The occasion for the deep drilling occured when the company found it necessary to remove a " Big Hill " which stood in the path of their open-pit enlarging operations.

Along the base of the hill 75 holes were drilled horizontally into the ground for a distance of an average of 101 ft ; some went to over 150 ft. After the drilling operation 25 quarrymen, using a 141-ft. tamping rod, pushed 1,500 lb. of high explosives into the holes which were 4 in. in diameter.

The blasting was done using instantaneous electric detonators and special low-freezing nitroglycerine. Each hole was loaded with dynamite sticks and, as already noted, a maximum of 1,500 lb. per hole was maintained. All blasting was done by a 220-volt a.c. blasting cabin equipped with an approved-type blasting switch.

The blast disintegrated the hill, the shock being felt miles away. It was also recorded on the Halifax University's seismograph where, until they were notified to the contrary, it was believed a minor earthquake had occurred. The rubble was then hauled away in 42-ton giant semi-trailer tractor-hauled vehicles, used by the company for the transportation of their asbestos-bearing rock.

After this the normal open-pit mining techniques was put into operation. Primary drilling is done from the top bench by means of drills mounted on steel derricks. Holes are



Loading the Blast-Holes.

Blasting Operation.

collared 15 ft. back from the face and sunk at an angle of 10° to 15° off the vertical, sloping towards the face. These holes are spaced from 3 ft. to 6 ft. apart, according to the rock formation. All holes are drilled to about 4 ft. below grade, thus requiring 40-ft. length of steel for the standard 35-ft. bench.

The same blasting equipment and techniques are used in this regular production as was done in the " big blast." The regular production blasting holes are drilled and loaded with 30 lb. to 50 lb. of explosive, with a maximum of 3,000 lb. for any one blasting operation. It is thought that it will be a long time before any pit mining operation will equal the blasting away of the " Big Hill."

Carborundum

Just 50 years ago the Carborundum Company's works was founded at Trafford Park, Manchester, to meet the demand for silicon carbide for refractories and abrasives. The anniversary year also happens to be the 60th of the discovery of silicon carbide by that versatile inventor, Dr. E. G. Acheson, who died 30 years ago. Acheson was the son of a blast-furnace manager, one who had no university course yet acquired from industrial experience an expert knowledge of hard materials suitable for drilling, boring, and cutting. In Moh's scale of hardness corundum comes next to diamond, corundum being natural alumina, that abrasive known also as emery and produced as " artificial " alumina and marketed as alundum, aloxite, and adamite. Alundum or " corundum " is relevant to the development of silicon carbide ; for not only did Acheson name " carborundum " because he believed it to be a compound of carbon and corundum, but the Carborundum Company also took up the electric furnace fusion of bauxite to produce fused alumina after Charles B. Jacobs developed the fusion process followed by slow cooling of the melt to yield an alumina pig.

Attracted by the industrial production of graphite in the electric furnace, by silicon carbide's potential uses for polishing precious stones and then for abrasive applications, Acheson took out patents for producing such materials, patents forming but part of a total approaching 70. With his use of the electric furnace at Niagara Falls Acheson became acknowledged as a pioneer in the electro-thermal industries, just as Moissan became famous for producing many metals in his simple furnace with its two electrodes in a burnt limestone block. Acheson had tried to " harden " clay by heating it strongly with a carbon fuel within a plumber's pot and it

was from noting some peculiar small but very hard crystals formed in that experiment that he arrived at carborundum. Using a mixture of coke powder and clay heated to a high temperature such tiny crystals were prepared and found to scratch glass like a diamond. (Silicon carbide is intermediate between corundum and diamond when the scale of hardness includes artificial materials.) In his electric furnace process the vaporizing of carbon brought graphite crystals forming on the cooler part of the furnace; hence Acheson after much litigation founded the Acheson Graphite Company to add to his score, thus producing a soft as well as a very hard material of value. He had left his time-keeping job at an ironworks to enter the electrical industry after odd jobs on railroads, joining Edison to gain much experience in research.

In 1902 silicon carbide was sold on the industrial market by the Polishers' Supply Company in London, this being due to its early use for polishing gems, but then came the adoption of carborundum in grinding wheels, varying in size from the tiny drill of the dentist to huge wheels of 6 ft. diameter. Although silicon carbide is more brittle than corundum abrasive particles of both products varying greatly in size, density, and degree of hardness, became adopted in conjunction with bonding agents to build grinding wheels, sharpening stones, and such articles. Ceramic resin, rubber, and shellac bonding agents became adopted, so that industry now has a wide choice of compounded materials. In 1922 the products of the Carborundum Company developed to a wider range when both silicon carbide and corundum were appreciated as highly-resistant refractory materials, while in 1927 was begun the production of crucibles. New tunnel kilns for the manufacture of vitrified abrasives improved the firing of the bonded ware, while later came the production of diamond abrasives.

M. SCHOFIELD.

Ore-Dressing Notes

(11) *Sampling*

A Useful Survey

In a symposium on " Statistical Methods in the Chemical Industry " held in London in January, 1959, a paper by P. E. Cook compares a variety of appliances and methods used in automatic sampling. The definition of " Sampling," with which he begins—" . . . the operation of removing a part, convenient in quantity for analysis, from a whole which is of much greater bulk . . . in such a way that the proportion and distribution of the quality to be tested are the same in both the sample and the whole "—sets forth an ideal toward the realization of which increasing attention is given in current practice. The more known about the basic science applied to the concentration of ores, the more the need for reliable starting data.

Sampling is a statistical business, based on the theory of probability and in practice it must minimize such variables as surging, unequal rate of passage, settlement from a pulp, or segregation of sizes in a bin. For moving material the best place to cut the sample is at a point where there is free fall and where a cut can traverse the falling stream at right angles. The intervals between cuts across this stream must compromise between the possibility of fluctuations in the ore from period to period and the problem of reducing a large sample to the dimensions required by the analyst with reasonable cost, speed, and efficiency. To deflect all the material for part of the time involves the shock of entry of the sampling device into the falling stream. Here an automatic cutter is superior to a manual operation, as it will always take its cut in the same way, whereas a hand-held collecting can varies somewhat each time.

The sample cutter in a mechanized system is usually set to move 18 in. per sec., but can be run faster (to reduce bulk taken) if there is no deflection of particles which should be included. The size of the sample depends on aperture, speed, and frequency of traverse. There should be almost instantaneous start and stop of each cut and a steady through-rate. Since the accuracy depends on both the frequency of the cuts and the quantity removed in relation to the passing volume, it may be justifiable to follow the primary deflection with a reduction cut in a secondary sampling device when pulp is being removed and there is no problem of particle size reduction between stages. A special form of Vezin sampler is available for such a purpose, which makes three cuts per second.

Errors in sampling fall into two broad classes—the statistical distribution error is a random variable, depending on the surging

or spottiness of the material. The operating error can be further subdivided into three types. Systematic errors could arise from contamination and in automatic work tend to be constant. In this case an allowance can be made for their correction which will remain reasonably reliable for the specific operation. The accidental error is one which can only be dealt with if it is seen to happen. The chance error in a operating run tends to cancel out provided its randomness has no element of bias favouring mistakes always on one side of the norm.

(12) *Water*

Progress with Electrodialysis

The removal of brine from brackish water has for some time been studied intensively in connexion with the de-salting of 2,500,000 gallons of water daily in the Orange Free State goldfields. Parallel research and its practical development are currently going forward in California, where it is hoped that a reasonably cheap treatment process for the de-salting of sea-water will duly emerge. The water treated flows through a series of de-salting units containing a number of compartments with walls of permeable membranes, called " plates," through which the flow proceeds. Two types of plate are possible ; one, called " homogeneous," is constructed primarily of ion-exchange resins, while the other, " heterogeneous," has its active resins bonded by means of an inert medium. The former type is preferred and pore sizes range from 5 to 20 Ångstrom units. The latter figure is reached with a styrene-based resin which carries 30% of water. Across the parallel plates along which the brackish water flows is imposed an electrical current. The amount required per 1,000 gallons of salt water rises from 8 kWh with solids of the order of 1,800 parts per million *via* 45 kWh at 10,000 p.p.m. to 135 kWh at 32,000 p.p.m.

In operation the stream flows between two plates across which the electrolytic current is flowing. These plates are " perm-selective "—that is, permeable to ions which bear the opposite charge to that of their own resins. Hence the positively-charged ions of sodium, calcium, magnesium, etc., in the feed-water can filter through the membrane nearest to the cathode of the applied direct current, while the chloride and sulphate ions go through the opposite plate, nearest to the anode. The adjacent channel on each side receives these ions and flushes them out with its own flow of contaminated water. Reversal of ionic migration across this displacing drive is not possible, since the membranes are oppositely charged in respect of each de-salting channel and therefore only permit counter-ions to pass.

Membrane costs about $12 per sq. ft. and is longlived. The overall cost for treating water with a salinity between 2,000 p.p.m. and 4,300 p.p.m. is between 45 cents and 65 cents per 1,000 gall. in a plant delivering 10,000,000 tons of de-mineralized water *per annum*. It is a long distance from salinity of this order to that of sea-water (35,000 p.p.m.), but the University of California's Sea Water Conversion Project is tackling the problem. Meantime it is observed by P. M. Rapier [1] that mineral deposits in localities where an ample supply of fresh water is not available, but there is brackish water, could be considered for exploitation provided the ore value can justify this moderately-priced method of water treatment.

(13) *Classification*

Better De-Dusting

A modified form of air classifier developed to meet the need for more thorough removal of *minus* 100-mesh material from crushed limestone is described in the November, 1960, issue of *Mining Engineering*. This material, required for special purposes in the glass

[1] *Engg. Min. J.*, Dec., 1960.

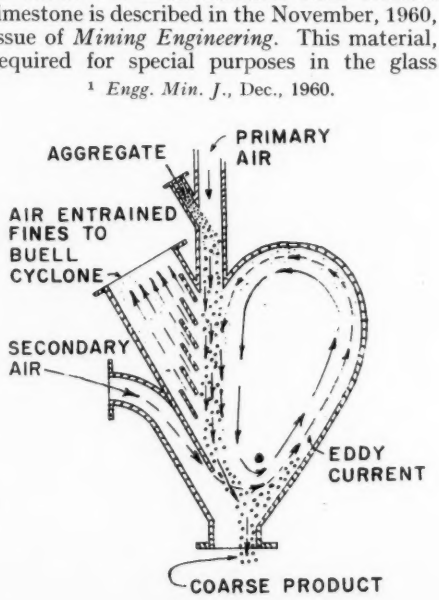


Fig. 1.

industry, is needed in the *minus* $\frac{1}{16}$ in. *plus* 100 mesh range, with less than 10% of *minus* 100 mesh in the product sold. The " gravitational-inertial classifier " works on a dried screened feed (through $\frac{1}{16}$ in.) and has no moving parts but is swept by air from two ports of entry. " Primary air " enters through the vertical duct shown in Fig. 1 and sweeps the limestone downwards. The coarser classified fraction continues to carry on vertically to the " coarse product " discharge, but is exposed *en route* to a controlled cross-current of " secondary air." This picks up the finer material in the feed and searches it in the area marked " eddy current " on the opposite side of the classifier. From this turbulent zone the undersize climbs and is centrifuged round by circulating air. As it rejoins the descending stream it is entrained by the vacuum at a third departure port which leads to a conventional air cyclone. Vanes set in this upward discharge duct aid in the control of the out-sweeping air which is steadily withdrawn. The separating mesh for the operation is controlled by regulation of the secondary air supply, aided by the inertial force which carries the particles downward. The kinetic energy of these particles is in turn controlled by the velocity of the primary air stream.

The classifier handles some 15 tons per hour and removes 22% as undersize, the misplacement of *minus* 100-mesh fines in the coarse discharge being between 3% and 5%.

Letters to the Editor

Tonsteins

SIR,—The paper dealing with Continental work on tonsteins contributed to your January issue by Mr. I. A. Williamson will be a useful English summary for geologists in this country. It is, however, quite untrue to suggest that many British Upper Carboniferous geologists are ignorant of the subject of which he writes. The use of tonsteins on the Continent as marker-bands in the Coal Measures has for many years been a matter of great interest to geologists both of the Geological Survey and of the National Coal Board, and a large collective effort has been made to detect such bands in this country. Opportunities to examine the Continental occurrences have been taken and collections of Continental tonsteins have been widely circulated.

Work on tonsteins was referred to in the " Summary of Progress of the Geological Survey of Great Britain for 1958," p. 62, where tonstein was recorded in the Cannock area. The " Summary of Progress for 1954," p. 36, contained a reference to a persistent fine-grained translucent rock in Nottinghamshire ; this was the first tonstein detected in Britain, although it was not at the time named as such.

Results to date have been interesting, but of limited practical value. This is partly because unlike some parts of the Continent, we already have a very good framework of fossil marker-horizons, particularly in the measures in which tonsteins are abundant—namely, fairly high in our productive Coal Measures. It is also partly because research so far suggests that tonsteins are not as well developed in some British coalfields as in the adjacent continental fields. For example, many of the bands in the Pennines area, where tonsteins have so far been found at about nine horizons, have been very thin, impure, and impersistent. It is because of the difficult and inconclusive nature of much of the work that little has been published, but some accounts are at present in the press.

Mr. Williamson states that most recent work favours the " diagenetic theory " of tonstein origin. There is, however, far from unanimity on this score ; it is possible that tonstein can originate in more ways than one, a view held by some Continental as well as some British workers. It may be noted that the apparent paucity of tonsteins in much of this country could be due to remoteness from the source of supply if the bands were of volcanic or detrital origin.

It is certainly a striking fact that tonsteins, widely regarded as valuable marker horizons in Continental Europe have been somewhat disappointing in this country, although they have been found in many of the coalfields of England, Wales, and Scotland. In spite of the similarities of the Coal Measures successions over western Europe it must not be forgotten that there are various important regional facies variations. One of these is in the manner in which non-marine lamellibranchs vary in abundance from place to place. Another seems to be in the development of tonstein bands.

R. A. EDEN.

GEOLOGICAL SURVEY OF GREAT BRITAIN.
EDINBURGH, 9.

March 13, 1961.

British Solomon Islands

SIR,—You should have already received for review a copy of our " British Solomon Islands Geological Record 1957–58 ", this being the third publication since 1955. The price, by the way, is 35s. Stg. or £A2 3s. 9d. (which is cost). There have been some sequels which may be of interest to you :—

The Protectorate's first hard-rock mine at Hanesavo began operations in January, 1960, and exported 176 tons of high-grade battery manganese ore up to July, 1960. However, the lease is shortly to be resumed by the Protectorate for failure to comply with the Mining Ordinance and is then to be the subject of detailed examination and sampling by the Geological Survey.

The British Phosphate Commission sent an engineering party in November, 1960, to examine the high- and low-grade phosphate deposits on Bellona. The party was well-equipped and landed a great deal of equipment on the beaches. Mr. Oliver Warin, Geologist with the Australian B.M.R., accompanied the team and deep trenches were excavated across the deposits. At the same time a hydrographic team made detailed surveys and selected anchorages. A decision has not yet been announced by B.P.C.

In October, following up the report on W. Guadalcanal in our 2nd publication (1958), the survey discovered good-grade copper sulphide ore at Hidden Valley on the southern slopes of Mt. Gallego. Preliminary sampling indicated 23·8 ft. width 2·19% Cu, 16·7 ft. width 2·82% Cu, 10·0 ft. width 3·75% Cu, and 18·0 ft. width 2·00% Cu. Nineteen assays were in excess of 2%, five in excess of 5%. The area is 3½ hours' easy walk from the coastal plantations, but had not been visited by anyone since the reconnaissance geological survey in 1954. There is a notable absence of private individuals with enterprise enough to get out into the uncomfortable bush in the Solomons ; there is no prospecting activity. However, a Canadian company has applied for a lease covering 20 sq. miles of the surrounding country and it is hoped that this coming dry season will see some activity.

Although not included in the 1957–58 Record, a three-year research project on the ultra-basic rocks of the Solomons began in January, 1957, and finished in November, 1959, and a new volume on the " Ultrabasic Rocks of the British Solomon Islands " by R. B. Thompson has been recently prepared. This project covered 170 sq. miles of ultra-basic rocks stretching over 380 miles of these islands and containing nickel silicates, chromite, and chrysotile asbestos. It was a useful co-operative venture involving two geologists financed by two overseas companies, supported by the Geological Survey's transport and field resources. As a follow-up, also partly financed by an overseas company, the Geological Survey is beginning a two-year systematic nickel-prospecting project in May this year.

A preliminary gravity survey of the Guadalcanal Plains, at 200-ft. centres, was made in 1960 by Dr. A. Day and two geologists (one from DeGolyer and MacNaughton, one Dr. Coleman of the University of W.A.) examined the sediments of North–Central Guadalcanal on behalf of Oil Search, Ltd., of Australia. The gravity survey indicated that the potential basin area was divided into two by an up-faulted block ; as this has considerably reduced the area the company decided to do nothing further, but has kindly made the three reports available for publication. As aspects of the geological reports are encouraging it is proposed that further work be undertaken by the Geological Survey in both geochemical and geophysical fields.

The B.S.I. Geological Record for 1959–61 (vol II) is now in the course of preparation and should be published at the end of this year.

J. C. GROVER,
Chief Geologist.

GEOLOGICAL SURVEY DEPT.,
G.P.O. BOX 62,
HONIARA, GUADALCANAL,
B.S.I.

March 24, 1961.

Montecatini Activities

Until recently Italy imported kainite from Germany and Israel at considerable expense. The find of kainite fields in Sicily will now allow the country fully to cover home needs and to export some 1,000 tons annually for the next 20 years.

The interest of the Montecatini company in the field of Sicilian sulphur was revived in 1952 when production at the Passerello and

Stincone mines was increased. The new period made it necessary to carry out an extensive programme of geological and geophysical research. During boring work the fields of S. Cataldo were found in 1953 and at once considered important. Until 1960 Italy obtained potash salts from the saline residual of beet processing, the ashes of almond shell, and a small quantity from salt mines. However, it was soon realized that the salt found at S. Cataldo was kainite, containing 12% to 17% potash together with carnallite. Montecatini has now patented and applied a treatment process of the ore by flotation very successfully, which has resulted in important savings besides yielding a commercial product.

From 1953–57 several excavations have been carried out, including three shafts to a depth of 450 m. and 12 km. of tunnels. At the end of 1958 the mine was ready for exploitation and the search for new fields begun.

In the mine itself exploitation and transport of the ore is largely mechanized. It is 40 km. out of Caltanisetta and produces 3,000 tons to 4,000 tons of salt daily (six trains of 20 wagons). In the drives the white rock salt vein contains red bands of carnallite and the greyish main lode (sometimes 30 m. in height) of kainite. A group of 10 men control machines—cutting, drills, loaders, and shuttle trucks. The workings are wide, well ventilated, and at air conditioned temperature. At the surface the mine is connected by a cableway of 18 km. to the treatment plant. Near the plant a reservoir of 1,000,000 cu. m. capacity compounds water from the River Platani to meet the needs of the plant which employs 500 people.

S. Cataldo is at one corner of a triangle, with Campofranco and Agrigento the others, the last on the sea. At Campofranco there was an old Montecatini plant, now replaced by the new one, unique in Italy, on the railway from Palermo to Agrigento. The plant treats daily 3,000 tons of kainite carrying 12% to 17% potash, as well as 3,000 of schoenite, an intermediate product. The ore is crushed and passed to a band conveyor, then loaded through a pneumatic system on to trucks bound for Porto Empedocle, where Montecatini has built one of the greatest plants in Europe for the production of complex fertilizers. Great silos have been built on the quays, as well as warehouses from which the fertilizers pass directly into the ships. Here also phosphates arrive from N. Africa. The plant annually produces some 30,000 tons of superphosphates, a quantity expected to reach 130,000 tons in the current year.

It has recently been announced that Montecatini is to build a plant for the working of pyrites at Follonica (near Grosseto). Work will start in April and should end in June, 1962. At first it will produce 17,000 tons per year of iron ore and 350,000 tons of concentrated sulphuric acid and employ 150 people. The pyrite comes from the neighbouring mine at Niccioleta by cableway. At a rate of 1,300 tons per day it will be roasted in two furnaces to liberate the sulphur while the solid residue will be conveyed to special furnaces for purification. The product so obtained, with a very high content of iron (65%), will be pelletized, while the sulphurous acid will go to the sulphuric acid plant, The heat generated in the roasting furnaces of the pyrite will be employed to produce steam that will feed a thermal power plant, which will have an output of 60,000,000 kWh per year.

G. GIORDANO.

Engineering Log

" Systems of Measurement," a broadsheet [1] recently issued by the independent research organization P.E.P., suggests that the inconvenience of contrasted national systems of measurement is becoming increasingly apparent in the world and that Britain stands at a cross-roads in respect of its units of quantity. There has been a landslide towards decimalization in Commonwealth countries in recent years and in this country two important reports have been published—the Hodgson Report of 1951 and the joint report of committees of the British Association for the Advancement of Science and the Association of British Chambers of Commerce in 1960. The first recommended the eventual adoption of the metric system and a change to decimal currency and also made various proposals which could be put into immediate effect for rationalizing the existing weights and measures system. The second recommended the adoption of a decimal coinage but, while sympathetic towards the metric system and advocating increased " decimal thinking," considered a change to the metric

[1] London. Price 3s.

system impractical at present. The proposals for immediate rationalization contained in the Hodgson Report have now been incorporated in the Weights and Measures Bill at present before Parliament. The broadsheet summarizes the relevant provisions of the Bill and describes the legislation contained in the Bill as " sound, sensible—and minimal."

* * *

In 1956 the total of lubricating oil additives sold was 1,350,000 tons. Half were detergents, a quarter viscosity index improvers, and 11% anti-oxidants. The rest included pour point depressants, extreme pressure additives, and oiliness improvers. The oil in a petrol engine has two main jobs—reduction of friction and removal of heat. It must be stable under trying conditions, particularly when the fuel may include leaded compounds, chlorine, and bromine. Among the anti-oxidants which combat chemical deterioration are such sulphurized compounds as esters, terpenes, and olefins, alkyl and aryl phenol sulphides, and metallo-dithio-carbonates—all names which will strike a chord in the ears of the flotation chemist. Then there are phosphorus compounds and sulphur-phosphorus ones and finally amines and phenos for moderate temperatures. The detergents are used to combat the bad effects of solid decomposition products. They must contain a metal—calcium, barium, magnesium, aluminium, or tin—coupled with a sulphonate, hydroxyl, carboxyl, or mercaptan and connexion to an organic group of high molecular weight which promotes oil solubility. The viscosity improvers counteract the tendency of oils to become thicker when cool and thinner when heated. They are polymers from isobutane, methacrylate esters or styrene and exist in colloidal suspension in cold oil, going into solution as the engine warms up. Pour-point depressants prevent solidification of wax crystals from cold oil, apparently by coating these and preventing their coalescence, so that tiny particles of wax remain suspended in the fluid oil. The compounds used are paraffin wax, aromatic condensation products, or polymerized methacrylate esters.[1]

* * *

Among the publishing activities of the Department of Scientific and Industrial Research are its single-sheet " Technical Digests," which briefly describe " useful items in technical literature " and tell anyone interested where further information can be obtained. Among those for the last quarter of 1960 a few selected almost at random as having possible interest for mining engineers and metallurgists may be mentioned. A safety device for warning the operator of a mobile crane or similar plant of his approach to overhead power lines uses its detector probe to pick up induced current and give the driver a warning signal. A new process in powder metallurgy produces dense non-porous metals with self-lubricating properties and good machinability. A centrifugal pump handles slurries on a torque-flow system, the impeller being located in a recess and being used only to create a vortex. Polythene-coated paper bags, sacks, and multi-walled containers give special protection to small machine parts and to hygroscopic materials. A novel form of pantograph transfers master letters from a template to drawings, with a range of size and shape modifications. Disposable paper overalls drape well, look smart, are resistant to alkalis and acids, are flame-proof, and for special purposes compete with textiles. A suspension rail is made for hanging large charts and drawings temporarily on a wall. These dip samples give some idea of the range of matters dealt with in the D.S.I.R. digests.

* * *

A simple field test for detecting caesium and rubidium in rocks, clays, and mineral waters has been developed by the United States Bureau of Mines.[1] Designed for use by prospectors, geologists, and mining engineers, the test requires only a few chemicals and inexpensive equipment, yet is capable of detecting cesium and rubidium in quantities as low as 60 parts per million. The chief uses of the two elements are in minute quantities in infra-red devices, in photoelectric cells, in electronic vacuum tubes, and scintillation counters, and in larger quantities as ingredients in medicines and ceramics. Prospective new uses include ion-propulsion fuels, plasmas in thermionic converters to change heat to electricity, and heat-transfer media in nuclear power systems.

* * *

[1] *Inst Pet. Rev.*, March, 1960.

[1] DEAN, K. C. and NICHOLS, I. L. *Rep. Inv. U. S. Bur. Min.* 5675.

An aerosol pack is now marketed which gives a tin plating to metals. It contains metallic tin, flux, and a chemical cleaner. These are sprayed on to the surface and the metal is then heated to soldering temperature, when a smooth tin coating appears. Alternatively the mixture can be applied direct to the heated metal. It is stated to produce superior soldered joints on copper or galvanized fittings and is marketed in America as " Tin Swipe." [1]

* * *

A pre-stressed section of underwater tunnel 407 ft. long was placed on the sea-bed near Stockholm recently. It is to form part of the railway system due for completion by 1964 and was built in two sections. These were joined near the site of deposition, which had been prepared by making a submarine ditch. The tunnel was then towed into position, suspended at intervals, and gently lowered a few inches at a time by admitting water into its inbuilt water tanks. It now rests at each end on concrete, the bottom being 46 ft. down with a clearance of 23 ft. for shipping. Ultimately the length will be 525 ft. and intermediate plinths will be added connecting it to the rock bottom.

* * *

In 1895 Dr. David Bruce isolated the parasite transmitted by the bite of a tsetse fly, but human sleeping sickness as a result of this transmission was not recognized until 1903. From the early 'twenties on war has been waged continuously against the tsetse fly, which has from time to time been eradicated over large areas, only to return. On the whole it has spread into new zones. In Northern Rhodesia over 90,000 sq. miles are infested. Both sexes of this blood-sucking fly can carry the parasite, with each species having its own marked habits and favoured growth areas. One common factor is that the fly can only exist with blood for food. It is highly susceptible to water loss from its body and needs an intake of blood every two to three days. The three main methods of attack are restriction of the breeding areas by clearing the bush favoured by the fly; removal of food supply by clearing out the game, and use of insecticides. If game is destroyed a 6-ft. high fence must then be used to prevent re-occupation. After bush has been cleared human settlement is needed if this clearance is to be permanent.

[1] *"Tin", Jan.*, 1961

News Letters

BRITISH COLUMBIA

March 6.

Copper.—The British Columbia Legislature has given first reading to the " Copper Bounty Act " following the Government's announced policy of encouraging the establishment of smelting and refining facilities within the Province. The Act authorizes the Minister of Mines and Petroleum Resources " to enter into an agreement for the payment to any person, over a term of not more than ten years, of a bounty of one cent on each pound of blister copper; or on each pound of refined copper produced from ore or concentrates mined, smelted, and refined within the Province, or both, but of not more than $250,000 in any one year or more than $2,500,000 in all."

British Columbia has had many copper smelters during its mining history. At one time three smelters operated within a few miles of each other in the Boundary District, treating the ores of the Phoenix and Greenwood mines. Three small smelters on Vancouver Island operated at one time on the marginal ore of properties which later were grouped into Tyee Consolidated Mines, Ltd. The last smelter was the one operated by the Granby Consolidated Mining, Smelting, and Power Co., Ltd., at Anyox, and it ceased operation in 1935 when the Hidden Creek mine was worked out.

Portland Canal.—Granduc Mines, Ltd., is to resume exploration and development in a major scale during the coming season. The ore zone will be explored both north and south of the section at present developed which extends for a length of 4,600 ft. and over a vertical interval of 1,700 ft. and in which indicated ore reserves have been estimated at 25,600,000 tons assaying 1·62% copper. Projected northward extension of the ore-body will be explored by 15,000 ft. of surface diamond drilling in an area in which a magnetic anomaly was found by ground work. Because of the difficult terrain, the drills, camps, and crews are to be transported by helicopter. Work is also planned on the Granduc structure, on the south side of the glacier opposite the mine, where mineralization is exposed in inaccessible cliffs. This work will entail the driving of an adit 500 ft. long to provide essential drill stations away from the edge of the glacier and free from the danger of falling rock. Initial plans call for 7,000 ft. of drilling from stations in the adit. During 1960 an investigation was made of the Unuk River watershed by ground and airborne magnetic surveys and by general and

detailed mapping. Although no ore-bodies were discovered four prospects of sufficient interest will receive further mapping, sampling, and drilling during 1961 at an estimated cost of $59,000. A small crew commenced rehabilitation of camp and equipment in February. Some 200 tons of fuel, supplies, and drilling equipment are to be moved to the property by air in March, when driving the South adit will commence. The company has budgeted $500,000 for the season's work. The funds will be provided by the controlling companies—Granby Mining and Newmont Mining Corporation of Canada.

New Westminster.—Giant Mascot Mines, Ltd., has purchased the 49% interest held by Pacific Nickel Mines in Giant Nickel Mines. The consideration was $475,000, of which $250,000 was paid in cash with the remainder in five equal monthly instalments bearing interest at 6%. The transaction represents a very favourable return of capital to Pacific Nickel and the sum is deemed to be exempt from taxation and permits Giant Mascot to conduct the nickel-copper mining operation in its own right and therefor utilize the company's current deficit of $2,601,609 for tax consideration; Giant Nickel's period of tax exemption terminated on March 1. Since milling was commenced, July 7, 1959, to November 30, 1960, Giant Nickel treated 353,140 tons of ore averaging 1·01% nickel and earned a gross operating profit of $1,059,000.

Kamloops.—Early production by the Bethlehem Copper Corporation was virtually assured when an agreement was signed by the company on March 3 with the Sumitomo Metal Mining Co., Ltd., of Tokyo. The approval of the Japanese Government is required, but the contracting parties have little doubt this will be obtainable. Sumitomo has agreed to purchase 400,000 Bethlehem treasury shares at $1·25 (U.S.) per share to provide $500,000 of immediate working capital. In addition Sumitomo will advance as required $5,000,000 to Bethlehem as a loan at 6% interest. It is anticipated that a further million dollars will be available as loan from local banks. It has been agreed to contract all mining and thereby save $1,500,000 on machinery and equipment. Bethlehem will build a mill of 3,000 tons daily capacity, planned for enlargement to 5,000 tons, the target for production being December 1, 1962, when the higher-grade ore of the East Jersey zone will be treated. By April 1, 1966, it is planned to have the enlarged capacity functioning and the major supply of mill feed will be gradually transferred to the Jersey zone. The agreement calls for delivery to Sumitomo of all production for 10 years after milling commences. As at present calculated this will entail the milling of 3,500,000 tons from the East Jersey zone and 8,500,000 tons from the Jersey zone for a total of 12,000,000 tons containing 193,000,000 lb. copper with a gross value of $57,900,000 on the basis of 30 cents per lb. for the metal.

Lillooet.—Development of the " 77 " vein on the 38 level of Bralorne Pioneer Mines has established persistence of this rich ore-shoot to a depth of 450 ft. below the previous lowermost development on the 35 level. Mr. Franc. R. Joubin, the company president, states that if the development continues along the present pattern the new ore will add three years' life to the operation

Osoyoos.—Friday Mines has entered into an agreement to take over the mine and mill of Keremos Mines at Olalla and four Crown-granted claims of Hedley Monarch Gold Mines. Friday has paid Keremeos $4,000 and agreed to pay $20,000 after an examination period extending to June 30, 1961. The Keremeos property is equipped with a 40-ton mill which has treated 2,000 tons of ore assaying 1·5% copper and 1% molybdenite.

Slocan.—Meta Uranium Mines has advanced $5,000 for an option to purchase the Arlington and four other claims in the Slocan District for $100,000. The Arlington mine is to be rehabilitated at once and further drilling of the favourable zone will be conducted.

Yukon.—The 1960 value of mineral production in Yukon was $12,179,852, as compared with $12,592,378 in 1959. Gold production of 77,770 oz. valued at $2,638,736 was considerably above the 1959 figure of 66,960 oz. valued at $2,247,847. Cadmium value of $203,788 was also ahead of the 1959 value of $181,440. The production values of silver, lead, and zinc, however, were lower: $6,011,779 ($6,192,556), $1,837,919, and $1,377,216 ($1,621,375) respectively. (The figures in brackets represent 1959 values.)

Turkey.—Utica Mines, Ltd., a British Columbia company, has purchased the Karaburum mercury mine in the extreme western section of Turkey. The mine had a record of production when operated by British interests prior to World War I, but has been idle since that time. Mr. W. C. Ralston, a vice-president of Utica, who is visiting Vancouver briefly since commencing his resident direction of company operations in Turkey, states the property can be equipped for production at a cost of $100,000, which sum will be supplied to the newly-incorporated operating subsidiary—Turkan Mining and Trading Co., Ltd.

EASTERN CANADA

March 24.

Ontario Gold Output.—The output of the 30 producing gold mines in Ontario for January is returned as 227,771 oz. of gold and 28,776 oz. of silver, valued at $7,901,743, from 804,026 tons of ore milled.

Porcupine.—Preston Mines, Ltd., the continuing corporation following the amalgamation of Preston East Dome Mines and the Stanleigh Uranium Corporation suffered a loss of $529,460 in the four months to December 31 last. The gold operation at South Porcupine produced 53,885 oz. of gold from 227,100 tons milled in the year to that date. At Stanleigh mining continued until November and the mill closed down in January, the uranium contract having been taken over by Rio Algom Mines, the amalgamation of Algom, Milliken, Northspan, and Pronto. In the first six months of amalgamation Rio Algom made a profit of $6,231,042.

The report of McIntyre Porcupine Mines, which celebrated its 50th anniversary on March 16, for 1960 shows a consolidated net income for the year of $2,392,246. At the McIntyre mines the 775,596 tons of ore milled yeilded 217,650 oz. of gold and 34,060 oz. of silver. In the Castle division 23,291 tons of ore were treated and 1,252,222 oz. of silver and 4,210 lb. of cobalt were recovered. The company has explored further the mineralized copper zone in the Pearl Lake property and an area between the 1,625 and 3,375 levels being blocked out is estimated to contain 4,800,000 tons of ore grading 1·04% copper with 0·023 oz. of gold per ton.

Elliott Lake.—The converted Pronto mill of Rio Algom Mines is now treating copper ore from the Pater mine at an initial rate of 500 tons per day with a target of 750 tons per day for later in the year. Ore reserves are said to be about 1,000,000 tons averaging 2% copper. The Rio Algom report states that a road from Pater has reduced the truck haulage distance to about 2 miles.

Rio Algom is also to deepen the shaft at Nordic a further 400 ft. in preparation for extended work.

Manitoba.—It is reported that Denison Mines is to explore an iron property about 20 miles south-east of Moak Lake. An occurrence of magnetite has been found at one end of an anomaly 10,000 ft. long discovered by aerial survey.

Quebec.—In the first 10 months of 1960 gold shipments from Quebec amounted to 859,761 oz. and those of silver 3,686,298 oz., figures which compare with 834,621 oz. of gold and 3,512,775 oz. of silver in the corresponding period of 1959. Asbestos output in the period was 855,083 tons, against 804,226 tons.

During 1960 New Calumet Mines treated 100,642 tons of ore and recovered 13,779,735 lb. of zinc, 3,551,520 lb. of lead, 885 oz. of gold, and 307,782 oz. of silver. The ore reserves at the end of 1960 were estimated to be 310,132 tons grading 8·72% zinc and 2·57% lead, with 0·021 oz. of gold and 5·34 oz. of silver per ton.

AUSTRALIA

March 22.

Uranium.—The future for uranium may well become a problem of some difficulty. Australia's four producers Rum Jungle, South Alligator Uranium, Mary Kathleen Uranium, and Radium Hill have worked under satisfactory contracts due to expire in 1962–63. These companies have reserves and prospective ore well ahead of the termination of the present contracts and will be faced with competition in the open market. The development of atomic power has been disappointing and in Australia coal and oil have held their position. Coal costs for power generation can be less than those of uranium and the fast growing policy is to build thermal power stations on the coalfields, deliver coal straight into the stations, reducing transport as far as possible, and taking advantage of belt-conveyors. It seems, therefore that coal is likely to hold atomic power at a distance and that local uranium producers must depend upon the requirements of the world market, which will become highly competitive.

Latest advice from Mary Kathleen Uranium shows production for 1960 as 1,475,851 lb. of uranium oxide from 478,626 tons of ore. Ore reserves are stated at 4,507,030 tons with a grade of 3·29 lb. uranium oxide per ton. Indicated reserves, outside the bounds of the present designed open-cut, are 300,300 tons with a grade of 2·77 lb., while possible ore is estimated at 1,235,700 tons and its grade as 4·17 lb. uranium oxide.

Rum Jungle has worked out the orebodies originally discovered by open-cut and the mill has yet a substantial operation period on the stockpiled ore. Prospecting in the vicinity by Territory Enterprises, the operating company for the Commonwealth Government, has proved a new, large ore-body, stated to be equal in grade and tonnage to the two deposits worked. It will also be worked by open-cut with, possibly, stockpiling of the broken ore. The Government has now announced that operations at Rum

Jungle will be continued after expiry of the present export contract, a decision which follows a comprehensive survey of the Australian industry. Profits earned under the export contract will be re-invested to continue operation of the treatment plant.

South Alligator Uranium has sufficient ore in sight to meet commitments to the end of the year. The position at Radium Hill is not clear in actual figures, but is believed to be satisfactory. Despite the discouraging immediate future, exploratory work is in progress by aerial surveys, geological, and geophysical methods. Regions under investigation are the Mount Isa–Cloncurry country in Queensland ; in New South Wales, a scintillometer survey is being made round Broken Hill ; in Western Australia, Hall's Creek, Carnarvon, Norseman, and Boorabbin are under examination. Search is in progress in the vicinity of Radium Hill and in the Northern Territory Roper River is a selected area and further work is to be done in the neighbourhood of Rum Jungle.

Coal.—The attention of the Commonwealth Government is being called to the competition of oil with coal within the country and a conference is to discuss the matter. The coal-mining industry has made a wonderful effort in rehabilitating itself and is re-establishing an export market. It is claimed that this flourishing industry is now threatened by loss of coal markets in its strong centres in Australia to cheap residual oil from the refineries, which is being dumped at prices with which the coal industry cannot compete. If this dumping is continued it will mean the closing down of collieries on several fields. An approach is to be made to both the Commonwealth and the New South Wales State Governments to curb the conditions which threaten the industry.

The Japanese steel industry is becoming increasingly active in its demand for Australian coking coal, a demand stressing the urgency for the modernization of the coal ports to permit the more rapid loading and turn-round of colliers and the accommodation in the coal ports of 30,000 and 40,000 ton ships. In Queensland attention is now centring in the Kianga field where open-cut operations are possible, with the delivery of large tonnages of coal. The capacity of the existing railway will be inadequate to move the tonnages that are being negotiated and the Japanese are prepared to spend £A8,000,000 in the development of the Kianga-Moura coalfield and on a new railway, 110 miles in length, from the field to the port of Gladstone, under a joint Australian–Japanese agreement.

Figures recently released by the Queensland Coal Board, for operations in 1960, give the completely mechanized collieries as 13·8% of the mines. Output per man-shift in completely mechanized mines for the first half of the year was 17·51 tons at the coal face and 5·27 tons overall. In part-mechanized mines, which totalled 21·41% of all collieries, output at the face was 9·68 tons per man-shift, or 2·86 tons overall. In the non-mechanized mines, which were 57·26 of all mines, output per man-shift at the face was 6·92 tons, or 2·87 tons overall. Continuous miners were introduced in 1960.

Copper.—An event of note is the production of the first drum of stranded aerial copper wire made at the plant of Copper Refineries, Ltd., at Stuart, North Queensland, and delivered to the Southern Queensland Electric Authority. The cable was manufactured at the rod mill and wire plant of the refinery, which is a subsidiary of Mount Isa Mines, Ltd., and which refines the output of the Mount Isa smelter. Capacity of the plant is being increased. The Stuart refinery has severely affected the operations of Electrolytic Refining and Smelting Co. at Port Kembla, New South Wales, which was the only copper refinery in Australia.

In addition to Mount Isa's copper, Port Kembla's smelter has also lost the treatment of copper concentrates from the Northern Territory, for which Japanese buyers have been able to offer a better tariff. Port Kembla's operations will be hit still more if the concentrates from the Ravensthorpe Copper Mines, in Western Australia, go to Japan, as is probable, for the Japanese have bought a substantial interest in the company.

Broken Hill Proprietary.—Despite the three weeks strike at the Broken Hill Newcastle works in January the steel ingot and pig-iron production are above the record levels of 1959–60. Tin-plate production at the Port Kembla plant was unaffected by the strike. The company has installed a tenth hot-dip tinning line, bringing the total capacity for hot-dip tin-plate to 113,000 tons per year. To meet the growing demand for steel plates a new mill is to be built at Port Kembla, at a cost of £A12,000,000.

Papua.—Pacific Island Mines, Ltd., has been prospecting for gold on Misima Island for more than a year and is making interesting progress. Prior to the war gold mining was carried on with success by the Cuthbert's Misima Company. During operations by the present company the work done included 33,000 ft. of costeans for reconnaissance purposes and 4,500 ft. of costeaning with more definite objective ; 240 ft. of adit driving and 80 ft. of cross-cutting ; 3,000 ft.

Edwards Shaft, Great Boulder.

of roads have been constructed and about 400 tons of ore have been stockpiled.

Cloncurry.—A company has been formed in Sydney to undertake cobalt production near Selwyn, in the Cloncurry country, North Queensland. Mining at Mount Cobalt was carried out between 1924 and 1927 and was then suspended because of prolonged drought and shortage of water. Extraction of metallic cobalt by chemical methods is to be practised. The company is Australian Cobalt Development, Ltd., with a capital of £100,000.

Western Australia.—The Great Boulder Mine continues to develop well but of particular interest is the work at deep levels. At the Main shaft 142 ft. at the 3,250-ft. level assayed 8·4 dwt. over 6 ft. and at the 3,400-ft. level 88 ft. averaged 5·7 dwt. over 6 ft. At the Edwards and Hamilton shafts good developments are also reported.

Central Norseman reported better values in the Crown Reef workings in February. At No. 22 level, the south drive was advanced 83 ft. to 4,602 ft.; from 4,425 ft. to 4,502 ft. ore averaged 19·8 dwt. over 48 in.; rising from this level gave an average assay value of 6·2 dwt. over 48 in. for 81 ft. At No. 25 level the south drive was advanced 250 ft. to 418 ft.; from 338 ft. to 368 ft. values were 12·3 dwt. over 48 in. followed by low-grade ore. At No. 29 level the south drive was driven 162 ft. to 1,188 ft.; values from 1,152 ft. were 10·2 dwt. over 48 in. Cross-cutting is in progress at the No. 32 level.

FAR EAST

March 14.

Malayan Tin Industry.—Fears have been expressed that the increased revenue required to further the Government's plans for social improvement may result in such impositions as are likely seriously to affect the tin industry. At the recent meeting of Petaling Tin, for instance, the chairman said that the imposition of heavy taxes on the tin industry can have such a stultifying and crippling effect that production by many of the country's producers becomes uneconomical. "There comes a point, and it would appear to be not far distant, where the numbers able to carry the burden will be considerably fewer. . . . A policy which discourages operations and renders uneconomic the exploitation of lower grade deposits . . . is irreconcilable with the problems of maintaining this country's position as a major world producer of tin. . . . It would appear that the time is appropriate to review the future of the industry in relation to the Government's policy on financial and land matters."

It is reported that a Japanese tin smelter with a production capacity of 12,000 tons a year is to be set up at Port Swettenham. It is to be built by the Ishihara Sangko Kaisha, of Osaka. The Japanese concern is expected to own the greater part of the shares, while the rest of the money will be raised locally. It is anticipated that the smelter will be completed by the end of next year.

Steel Mill.—Mr. P. L. Schereschwesky, a French consultant, heads a United Nations iron and steel survey mission which is now at work in Singapore making a detailed study of a proposal to set up a mill there.

Bauxite for Sarawak.—Dr. F. H. Fitch, Director of Geological Survey, recently announced that arrangements had been completed with the Overseas Geological Surveys in London for Dr. D. Masson Smith, of their geophysical section, to visit Sarawak in April to undertake two months' field work in connexion with the search for additional bauxite reserves. Preliminary tests of the magnetic properties of representative rock samples from West Sarawak have shown that the bauxite source rock at Sematin is considerably more magnetic than the others. Hidden extensions or additional occurrences of this rock can, therefore, possibly be mapped with the aid of a magnetometer If the magnetic contrasts are as strong as expected, and a suitable plane can be chartered, the ground instrument is to be flown over parts of West Sarawak to check whether an airborne magnetometer survey would be effective.

South Vietnam.—A plan for a U.S. $527,000 mineral survey in South Vietnam has, it is reported, been signed by its government and the United Nations Special Fund. In the course of the investigation the survey will provide practical training and experience for Vietnamese engineers. The United Nations is to provide one mining geologist or mining engineer to serve as project manager, one geologist experienced in general exploration, alluvial prospecting, and geological mapping, and one diamond driller.

Pakistan.—Coal production in Pakistan last year rose to more than 800,000 tons—the highest since the country became independent in 1947. A spokesman of the Bureau of Mineral Resources, giving this information, added that he hoped the annual output figures would increase to about 2,000,000 tons during the next four years. Production of other minerals, particularly chromite, had also increased appreciably, he said.

JOHANNESBURG

March 28.

Nuclear Research.—The South African Atomic Energy Board is shortly to initiate the erection in the Hartebeestpoort Dam area, west of Pretoria, of a nuclear research laboratory, which is to be ancillary to a research reactor. The design of the latter in Washington, U.S.A., based on the Oak Ridge installation with certain modifications to bring it into line with the requirements of the South African nuclear research programme, has been approved, the contract has now been awarded, and erection is scheduled for early next year. The unit should be in commission by about the end of 1963.

The location of a very high-grade uranium deposit in the Namib Desert near the Walvis Bay-Usakos rail-line and about 60 miles from Walvis Bay has been reported. In view of the present over-supply of the mineral there is no immediate prospect of any production from the deposit, which is privately owned.

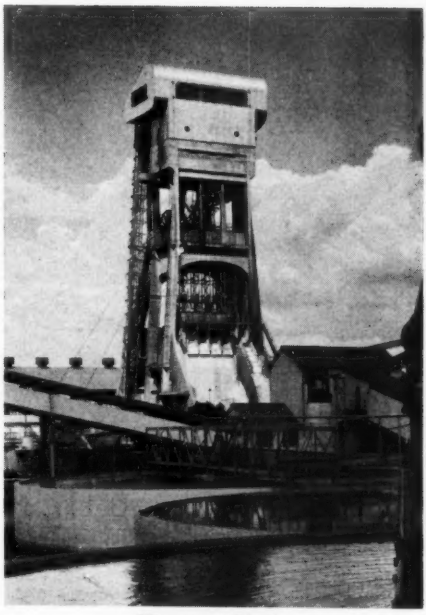
Sorting Process.—Further details have been made available regarding the K. and H. Radio-Metric and Colorimetric sorting equipment for mine ores, which, briefly reported previously, can be applied to gold, uranium, manganese, nickel, chromite, and other ores. After washing and sizing the ore is fed into a hopper, whence it is transferred by a vibrating feeder on to the patented conical in-line feeder. The latter—spinning at high speed—imparts centrifugal force to the ore, which is marshalled into a single line against the side-skirt plates. At the outlet from the conical feeder the pieces fall one-by-one equidistantly on to a short conveyor-belt, at the end of which they fall under gravity through a light zone emanating from a red neon tube operating at 5,000 cycles a second. On the other side of the light zone is a photo-electric cell. Owing to the 5,000 cycle operation of the neon tube, the ray is not affected by ambient light. In the light zone each piece is measured for length and the dimension transmitted to the scintillometer, which then measures for the same period of time.

In the uranium set-up, when the uranium content is less than a pre-set level, a compressed-air blast is triggered off and blows the piece out of the stream into a waste box. The air blast is not triggered off by pieces with a uranium content above the pre-set level and these fall (still under gravity) into the ore-bin. Suitable disposal systems handle the two sortings. The total distance from the point where the rock interrupts the neon light beam until it passes the blast jets is about 30 in. and any measurement of time—say, for a 2-in. piece—is less than 0·1 sec. To avoid background count the scintillometer is encased in about 6 tons of lead. Replacement of the mechanical blast valve need only be considered about every 50,000,000 operations or so. (Automatic counting is also considered.) The valve is capable of operating up to 130 times a second. The standard unit is adjusted to handle rock of a size of *plus* 2 in. *minus* 8 in. at a capacity of 25 tons to 50 tons an

hour. One operator can supervise six radiometric sorting units. Manufacturing rights in South Africa are held by Wright, Anderson (SA), Ltd.

New Mine Hose.—A plastic air-water mining hose, Compoflex 7008, has emerged from testing under difficult underground conditions over many months, with striking results. One mine standardized on 1-in. bore hose for air supply to rock-drills, the results showing better drilling results and reduced labour fatigue. At the second mine, where details of the testing are not yet available, testing over ten months—for a period in the mine's worst underground working conditions—disclosed no failures, no mends on some of the hose lengths, no serious wear on the covers, and considerable savings in the labour force. The hose was developed against a background of rising prices of rubber hose and the established failure of ordinary plastic hoses in use underground with compressed-air, especially in the 1-in. bore size. To provide the high-pressure performance required, a terelene criss-cross braiding and terelene reinforcement are embedded between the inner core and the yellow fluted cover, which are all bonded together. Special plastic grades are used for the inner and outer layers to give well-balanced toughness and flexibility in underground temperatures of 80° to 100° F. This temperature range indicates that the hose has been specifically manufactured for the temperature range mentioned and such misapplications as use under conditions of excessive sun-generated heat or with very hot air from portable compressors should be avoided, which conditions sometimes render the hose unsatisfactorily soft. These conditions do not obtain with piped compressed air underground. The smooth (inner) bore is oil-resistant—as is the outer cover—and offers minimum air-flow resistance. The fluted outer cover has been found resistant to abrasion to the degree that when the cover was deliberately cut away and slashed the hose still retained its pressure performance, provided the braids were not penetrated. The practice of using hypodermic pressure testing needles on the hose is not recommended as being detrimental and unnecessary. The hose is approximately half the weight of the corresponding rubber hose. Compoflex 7008 is patented and manufactured by Flexible Tubing Africa (Pty.), Ltd., from raw material plastics supplied by African Explosives and Chemical Industries, Ltd.

Transvaal.—The reinforced-concrete headframe of the six-compartment Margaret shaft of Stilfontein Gold Mining was recently modified to facilitate the installation of a four-rope



Margaret Shaft.

Koepe hoist on top of the headframe, which is additional to the two conventional ground-mounted double-drum hoists originally installed. The hoisting capacity of the shaft was thereby materially increased. The Koepe winder serves two compartments, which were previously used for upcast ventilation, and hoists from a depth of 4,300 ft. The upcast duty was transferred to one of the smaller shafts of the mine. The two converted compartments are now used mainly for ore hoisting and are on the one side of the shaft. The two centre compartments are used for both cage and skip hoisting, the latter being mainly for waste rock from underground. While, in the case of the two Koepe compartments, two long chutes discharge into the centre of a ground-level ore-bin (to minimize locking-up of ore in the dead-load), the two centre compartments are served by two shortened chutes, which discharge on to a cross-belt behind a concrete wall at the back of the ore-bin. This cross-belt transports the waste rock to a washing and screening plant at the side of the headframe. The next two compartments, on the opposite side to the two Koepe compartments, are used mainly for transporting men and materials and can be converted for rock hoisting according to normal cage/skip interchanging arrangements. The Margaret shaft, which is the main hoisting unit

of the Stilfontein mine, has an ore-rock conveying capacity of 320,000 tons a month.

In due course, as the Margaret shaft area becomes worked out, a sub-vertical shaft will be sunk to its south. This will serve the south-eastern section of the lease area, on the down-cast side of a major fault system. This sub-vertical will be connected with the Margaret shaft by a high-speed transfer level. About 4,000 ft. south-west of the Margaret is the site of the Scott shaft, where preparations for sinking to a depth of 6,500 ft. are well advanced This shaft will replace the Charles, when the Vaal reef area served by the latter becomes worked out.

Bechuanaland.—No new mines were opened up in the territory during 1960. Production from the Moshaneng asbestos mine, near Kanye, declined about 140 tons from the 1959 tonnage of 1,421 tons. Owing to financial difficulties the company operating the manganese mine near Ootse suspended production in September, but, despite that, both that mine and the second in the Bangwaketse Tribal Zone advanced 1960 output by 4,894 sh. tons to 25,032 sh. tons. The latter mine, at Kgwakgwe, commissioned a dense-medium separation plant, which contributed to raising output to 2,000 tons a month by the year-end and plans further expansion of output. Production at the second manganese mine may be resumed in 1961. While the establishment of new mines this year is considered unlikely prospecting will be intensified and should indicate by the year-end the potential of certain deposits being examined. Large reserves of sodium carbonate—sodium bicarbonate have been indicated in the Nata area, but their working for soda ash production depends on transport facilities to rail-head.

Bamangwato Concessions (Rhodesian Selection group) continued prospecting in the Bushman mine area west of and at the Magogaphate copper-nickel occurrence south-west of Francistown and at the latter advanced shaft-sinking and core-drilling. In the south-eastern Bangwaketse zone Rand Mines and the Marlime Chrysotile Asbestos Corporation examined known asbestos and manganese-ore occurrences. Johannesburg Consolidated Investment is now prospecting in the Batawana zone. The Anglo American Corporation completed prospecting in the Lobatsi zone on behalf of De Beers Consolidated Mines, while De Beers Prospecting (Rhod. Areas) extended diamond prospecting rights in the northern and central Crown Lands and is negotiating for rights over the major southern tribal zones. Negotiations are proceeding for an oil company to be granted an oil exploration licence over a large area.

General.—Worthy of note for the reasons stated are the following : The registration of the companies, Industrial Grit Distributors, Ltd. (R200.00), and Ultra High Pressure Units, Ltd. (R2,000.00), against the background of the De Beers and associated companies' plans to embark on the commercial production of synthetic-diamond grit and, against the background of exploratory programmes, the increases of capital by De Beers Prospecting (SA), Ltd. (R200,000 to R2,200,000), and by Rand Mines Exploration Co. (Pty.), Ltd. (R4,000 to R700,000).

Trade Notes

Brief descriptions of developments of interest to the mining engineer

Low-Pressure Stowing

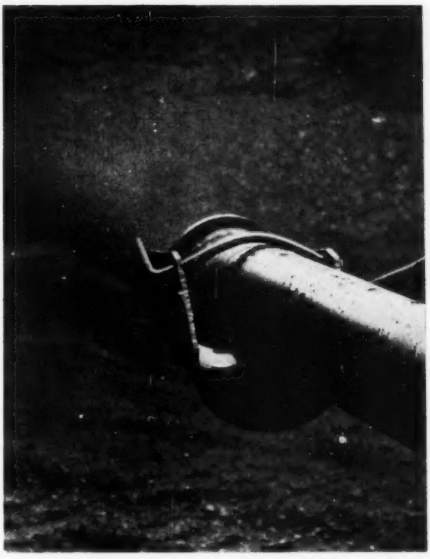
Some notes supplied by **Atlas Copco (GB), Ltd.,** of Hemel Hempstead, refer to experimental work on a low-pressure stowing method being carried out by the National Coal Board. For this purpose the stowing machine is placed at the face of the roadhead or, alternatively, in the roadway very near the face (thus reducing the length and complexity of the stowing column), and air is supplied by an inbye compressor delivering about 2,000 c.f.m. at a pressure sufficient to overcome the back pressure of a loaded stowing installation. Experience has shown that a pressure of 15 p.s.i., peaking up to 20 p.s.i., will give the stowing performance normally associated with the higher-pressure

installations more generally used. What was required was a compact machine of suitable size which demanded a relatively low horsepower—about 150—that had a free air delivery of 2,250 c.f.m. at 15 p.s.i., and that was air-cooled. One of the machines tried was one of the Atlas Copco screw compressor range, the U 18. This connected to a Brieden KZS 50 stower began its trials at Penallta Colliery, near Cardiff, last September.

For operation standard 6-in. bore-stowing pipe was used, a total length of 180 ft. *plus* one right-angle bend being required. Under these conditions a throw of up to 30 yd. was obtained when stowing at the rate of 80 tons per hour, producing a pack having a density of 83 lb. per cu. ft. This performance was obtained, it is stated, in spite of the fact that the resistance of the stowing line, before the introduction of the dirt, caused a back pressure of 10 p.s.i. to be created. Modifications resulting from noise-level tests resulted in comparatively low decibel readings, both intake and discharge silencers being fitted. The compressor drive was arranged direct from a 150-h.p. Bruce Peebles electric motor to the female rotor, which rotates at 3,000 r.p.m., the male rotor moving at 4,500 r. p.m.

After successfully completing its trials at Penallta the U 18, with stower, was transported to Cadley Hill colliery, Derbyshire, and installed inbye. There on a long-wall production face the machine operated most successfully for a trial period of three months, after which it was retained by the colliery for continued stowing operation. The face, 120 yd. in length, is completely stowed every two days and the present maximum length of pipe through which it is necessary to operate is 100 yd., although this is shortly to be increased in the next panel to be worked to 120 yd. The rate of advance is 5 ft. and the height of the seam which is being worked varies between 6 ft. and 7 ft. The stowing time totals 4 hours per day. Thus in each complete two-day cycle 465 cu. yd. of dirt are being stowed.

The screw compressor, it is considered, has definite advantages on underground service, having few moving parts and requiring little maintenance and infrequent overhauls. Completely oil-free air is delivered and there is no risk of oil fires, while filtering is no great problem even under such adverse conditions as prevail underground. In pneumatic stowing the actual blowing time is generally a third only of the total time, compared with two-thirds spent on preparing the face for stowing. Even if this proportion amounts to one-half, as it may

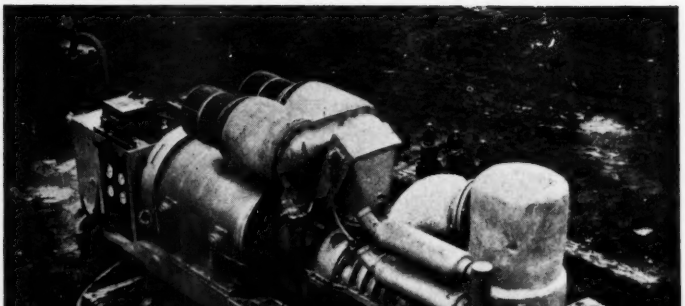


Stowing in Progress.

in a good installation, the air is only required for 50% of the stowing time at the most. When using inbye compressors the power may be cut off during the face preparation period.

The production of airborne dust is an operational difficulty but low-pressure stowing conditions enable relatively low air quantities to be used, so assisting in the constant struggle to keep airborne dust concentrations caused by stowing down as much as is possible.

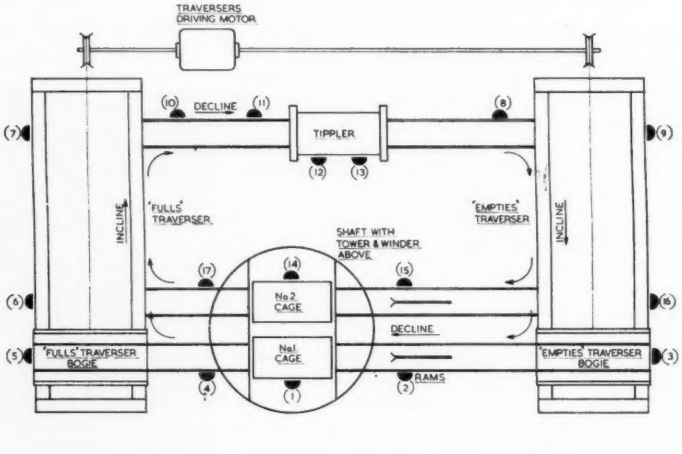
Typical Dirt Handled.



Atlas Copco U 18 Screw Compressor on Stowing Trial.

Automatic Handling Control

To demonstrate a new fully-automatic control system the **English Electric Co., Ltd.,** staged a model of a typical mine car system at the Electrical Engineers Exhibition held in London last month. The system has been designed for handling material at the surface—*e.g.*, for removing mine cars from a cage, emptying, and returning them completely automatically. The circuit layout shown consisted of a tower-mounted friction winder with balanced two-deck cages (one car per cage), "fulls" and "empties" traversers, tippler, and rams. When a full mine car has been raised it is rammed from the cage and an empty car pushed forward. As the cage falls with the empty the full car gravitates on to a traverser



English Electric Automatic Car Handling Control System.

PROXIMITY HEADS
(1) No.1 CAGE IN LINE
(2) CAR ON No.1 RAM
(3) BOGIE IN LINE WITH No.1 TRACK
(4) CAR CLEAR OF No.1 CAGE
(5) CAR FROM No.1 CAGE ON BOGIE
(6) CAR FROM No.2 CAGE ON BOGIE
(7) BOGIE IN LINE WITH TIPPLER
(8) CAR ON ARRESTER
(9) CAR ON BOGIE
(10) CAR CLEAR OF BOGIE
(11) CAR IN TIPPLER
(12) TIPPLER IN LINE
(13) TIPPLER PARTIALLY ROTATED
(14) No.2 CAGE IN LINE
(15) CAR ON No.2 RAM
(16) BOGIE IN LINE WITH No.2 TRACK
(17) CAR CLEAR OF No.2 CAGE

trolley, which is driven up a slight incline so that the car can gravitate off the trolley and into the tippler. The tippler turns the car through 360°, emptying its contents on to a conveyor-belt or hopper underneath. The car, now empty, gravitates on to the trolley of the "empties" traverser, is again driven up a slight incline to a point directly opposite the cage it has to enter, gravitates off, and is rammed, thus completing the circuit.

The sequence of operation demands that for reliable interlocking the positions of the mine car are detected by proximity heads, contactless sensing devices for ferrous material within their operating zone. The signal produced by the head is then fed into the "Unistat" transistorized logical elements responsible for sequencing and control. The output from the logic is then amplified further and this signal is used to operate the motor starter or solenoid or contactor as necessary. A layout diagram of a typical mine car circuit available is illustrated.

Personal

C. J. P. BALL has been awarded the Institute of Metals (Platinum) medal for 1961.

ARTHUR A. BRAND, chief of exploration for Newmont Mining Company, was distinguished lecturer for the Society of Exploration Geophysicists, at the February meeting.

W. A. CLEMENTS has left for Canada.

J. DAMEN has left the Netherlands for Liberia.

J. N. V. DUNCAN, O.B.E., has been elected chairman of the Rio Tinto Mining Company of Canada in succession to Mr. J. H. HIRSHHORN, who retired in January. Mr. Duncan remains as managing director of the Rio Tinto Company.

J. M. M. EWING has been elected the representative member for Gold Fields of South Africa of the Gold Producers' Committee of the Transvaal and Orange Free State Chamber of Mines, in place of Dr. W. J. BUSSCHAU, who recently resigned.

S. O. FORD is returning from Nigeria.

S. H. HAUGHTON, formerly Director of the Geological Survey in South Africa, has been elected F.R.S.

H. W. G. HIGNETT, managing director of Henry Wiggin and Co., Ltd., has been appointed a director of the International Nickel Co. (Mond), Ltd.

P. B. HIRSCH has been awarded the Rosenhain medal of the Institute of Metals for 1961.

R. C. HOWARD-GOLDSMITH is now in the independent Republic of Niger as a United Nations technical assistance expert.

R. G. S. HUDSON, Research Fellow in the Department of Geology, Trinity College, Dublin, has been elected F.R.S.

J. F. INCE has been appointed a director of the National Mining Corporation, Ltd.

A. JOSE has returned from Ghana.

F. LUDWIG has been elected president of the Mine Managers' Association of South Africa for 1961–62 in succession to Mr. E. G. AIRTH.

J. G. B. MICHELL is returning from Canada.

C. W. D. H. MITCHELL is now in Goa.

K. A. OLIVER has been appointed Chief Metallurgist of the Brightside Foundry and Engineering Co., Ltd.

MICHAEL S. REFORD has been appointed chief geophysicist for the Aero Service Group of Canadian Aero Service, Ltd.

O. M. SENIOR is leaving for India.

H. W. STRALEY, III, has returned to the United States.

J. VARLEY, refinery manager of British Copper Refiners, Ltd., has been appointed a director of the company.

W. J. DE VILLIERS has been appointed consulting engineer (methods and work study) of the Anglo American Corporation. Dr. M. G. ATMORE has been appointed assistant consulting chemical engineer of the Corporation.

Y. YOKOTE and S. NOMURA have been awarded the W. H. A. Robertson medal and premium by the Institute of Metals.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—Adolf HELKE, Dr.-Ing. (*Mainz*).

Associate Member to Member.—Norman Basil VINSON, A.C.S.M. (*Germiston*).

Associate Member.—Neil Welbourne BLISS, B.A. (*Salisbury, S. Rhodesia*); Eric John EASTERBROOK, A.R.S.M., B.Sc. (*Tring*); Cyril George FIGGINS, A.C.S.M. (*Chingola*); George Brian Joseph HALSTEAD, B.Sc. (*Mufulira*); Trevor Collier JAMES, A.R.C.Sc., B.Sc. (*Dodoma*); Stephen James MERRICK, B.Sc., B.A.Sc. (*Kitwe*); William Richard Noble SNELGROVE, B.A.Sc. (*Mufulira*); Francis Martin Haakon STEPHENS, A.C.S.M. (*Wolverhampton*); Donald George TREILHARD, B.A.Sc., P.Eng. (*Jinja*).

Student or Affiliate to Associate Member.—John ALDERSON, A.R.S.M., B.Sc. (*Skouriotissa*); Antony Arthur Carrick BREWIS, A.R.S.M., B.Sc. (*London*); Colin George CLOW, A.R.S.M., B.Sc., A.I.M. (*London*); Dinesh Chintaman KALE, A.R.S.M., B.Sc. (*Mysore*); Lin Chin TECK, A.C.S.M., B.Sc. (*Ipoh*); Valentine John MCSWEENEY (*Queensland*); David Fairfield ROGANS (*Orkney, Transvaal*); John Richard Curwen SPOONER, A.R.S.M., B.Sc., D.I.C. (*Hangha, Sierra Leone*); Fereydoon *Lahedi*, A.C.S.M. (*Teheran*).

Affiliate.—Colin BUTTERWORTH (*Egremont*); John Low Porter MACKENZIE, B.Sc. (*Brolan Hill, N. Rhodesia*); Derek Worthington OAKES (*Jos*); Frank George Llewellyn RUMBALL (*Rayfield, N. Nigeria*).

Student.—Derek Harry Heming BALLARD, B.Sc. (*Mufulira*); Ja'afar Bin CHIK (*Camborne*); Bruce COZENS, A.R.C.S., B.Sc. (*Ashanti Akim*); Ian Thomas DUNCAN, B.Sc. (*Nkana*); Robert Arnold GRAVES (*London*); Robert Inghram GUNN (*Bristol*); Lee Har SENG (*Brisbane*); Ian Stuart MOODIE (*Camborne*); Nicholas John SORSBY, A.C.S.M. (*Barakin Ladi*); Sinnasamy SUBRAMANIAM (*Camborne*).

Metal Markets

During March [1]

Copper.—The copper market was much less volatile than usual in March and prices fluctuated only within very minor limits.[2] During the month, however, values tended gradually to fall back overall as the various bull factors, such as they were, receded into the background. At the outset there was the continued anxiety over the Congo political situation, as well as further rumbles of discontent over the new Northern Rhodesian constitution to give the market some strength. With both of these factors dropping out of the headlines at still quite an early stage, however, it required a strike of dockers at Chilean ports, which interrupted copper shipments for nearly three weeks before it was finally settled, to prevent prices from sliding too far back, particularly in view of the still disappointing world February production and stock figures issued by the Copper Institute midway through the month. Had the strike been one to interrupt copper output rather than just shipments its effects might have been more marked. Certainly by its length it would have found some reflection in the overall supply and demand statistics, which at present show nothing but a substantial surplus.

Outside the United States copper consumption was again maintained at a high level generally during March, but new buying was fairly limited, most consumers being content with the metal coming forward from producers under period contracts. In the United States, although there was still little sign of any really marked upturn in business activity, copper fabricators were reported to be buying rather more metal than normal at one stage. However, even at its best this pick-up was by no means spectacular and indeed in the latter part of the month it had ceased to be a matter for comment.

The only other possible price-sustaining factor to emerge during the month was the news that with the U.S. Kennecott organization due to agree new labour contracts for its American workers in the summer, the unions are already thinking in terms of a substantial pay rise. As always when contracts come up for re-negotiation there arises the possibility, on paper at least, of a strike. This might give the market a firmer tone over the next 2 or 3 months.

United Kingdom copper consumption in January amounted to 59,155 tons, of which 45,187 tons were refined. U.K. output of primary refined copper in January was 10,208 tons and that of secondary refined 8,167 tons. End-January stocks of refined copper totalled 101,797 tons, as compared with 96,700 tons at the end of December. Blister stocks were also up at the end of January at 20,897 tons, compared with 17,752 tons at the end of the previous month.

Tin.—The tin market was again strong in March and prices climbed steadily with only minor setbacks from time to time. Just before the month-end cash metal reached its highest value since the Suez crisis of 1956.[1]

The strength of the market in the first two months of the year hardly needed underlining when the International Tin Council met in the first week of March and no one was surprised when it announced that it would not be applying quota restrictions to producer countries' exports in the second quarter. Following the Council's decision, however, it seemed everyone wanted metal—even United States enquiry picked up more than somewhat—and both London and Singapore markets were buoyant for the rest of the month.

Undoubtedly later on this year there will be more metal available as more mines are re-activitated after being closed during the worst

[1] Recent prices, pp. 200, 240.
[2] See Table, p. 240.

[1] See Table, p. 240.

depression in tin prices in recent years, but as long as new supplies continue to come forward at pretty well the same rate as they did in the closing months of quota restrictions last year it seems only a matter of time before £830 a ton is reached. Then there may be some selling from the buffer stock, although with a new Tin Agreement due to come into force on July 1, and ideally requiring a reasonably large initial buffer stock, sales may well be deferred unless prices show a tendency to rocket.

U.K. January tin consumption amounted to 1,803 tons and production to 2,292 tons, figures which compare with 1,588 tons and 2,396 tons in December. Tin stocks in the United Kingdom at the end of January were again up at 11,865 tons compared with 11,778 tons at the end of December.

Lead.—Until the International Lead and Zinc Study Group's meeting in Mexico City towards the end of March the lead market [1] was very steady overall, the attitude of mind of most interested parties being one of " wait and see " until the outcome of the Group's deliberations was made known. When the final communique was issued no one was surprised to hear that further supply curtailments had been decided upon, but many people were disappointed at the smallness of the cutbacks agreed for the remainder of this year. This found reflection in a slight drop in prices in the latter part of the month.

Just as the announcement of more restrictions caused no surprise, neither did the news that the United States Government had offered to acquire all the metal in producers' stocks on December 31, 1960. Some such move had been expected for quite some weeks and indeed the U.S. intention to make such an offer as a positive gesture towards relieving the gross oversupply had leaked to the Press some time before the meeting. Without such an offer it is doubtful whether any further cutback in supplies would have been agreed, although it is noticable from the final communique that more countries than ever before will be restricting output in future.

U.K. lead consumption in January totalled 31,145 tons, while production of English refined lead in the same month was 6,307 tons. Stocks at the end of January amounted to 71,660 tons, as compared with 70,853 tons at the end of December.

Zinc.—Zinc was a basically steady market [1] during March, like lead. The International Study Group, meeting in Mexico City, was not expected to announce any supply curtailments, but, just in case, traders for the most part adopted a cautious attitude to their dealings, with the result that prices failed to develop either an upward or downward trend. On the other hand, the lack of much overall movement did also reflect the basic balance which exists between zinc supplies and demand at the present time and has existed since the cessation of heavy United States export offerings some week ago. Unless there should be a resumption of American offerings, or of bulk offerings from another source, there is no reason to believe that the setback in zinc prices following the Study Group meeting was other than a temporary factor.

As long as zinc consumption holds up at its present levels producers should have little to worry about, but there is a feeling in some quarters that the market is vulnerable in that zinc's main outlets are restricted to only a few industries of which the motor industry is the most important. With the motor industry, although the immediate signs are healthy enough, there is some doubt as to the future and observers are now talking of the need to watch production and export figures closely over the next few months to see what effect they might have on future zinc consumption.

January zinc consumption in the U.K. totalled 28,737 tons, while output amounted to 6,263 tons. End-month stocks of the metal stood at 63,152 tons, as against 59,397 tons at the end of December.

Iron and Steel.—March was a steady month for the steel market in the United Kingdom. While pressure for supplies generally showed a further easing off, total ingot production was maintained at a fairly high level. The bright feature about March was the recovery in the motor-car industry. Many workers are working longer hours and some men made redundant last autumn have been recalled. The wide strip mills have resumed near normal production, but in any case there are no fears of a shortage of sheet supplies, as ample stocks are held by the car factories.

An easier tone has appeared in the constructional steel market. While rollers of angles, joists, beams, sections, etc., are still operating at a high level working off their heavy order loads, they are finding that the current intake of orders has shrunk. One result of this trend is that the mills are able to offer shorter delivery dates.

Demand for plates is still at a brisk pace from a wide range of consumers and the call for reinforcing rounds remains impressive. The railway materials market, however, is still depressed.

[1] See Table, p. 240.

Meanwhile, there is a considerable body of opinion in the steel industry here who believe that the sharp rise in coal prices last year, together with other increased costs, should be reflected in higher steel prices. To this body has been added the weight of the British Iron and Steel Federation, whose president, Mr. C. R. Wheeler, stated in his annual report that although the marked increase in output last year was naturally accompanied by an increase in total steelmaking profits, the average profit margin changed little as against the previous year. Indeed, he added, profit margins came under considerable pressure from rising costs in the closing months of the year. So far the Iron and Steel Board, which fixes British home steel prices, has remained silent.

Iron Ore.—Supplies of iron ore remain exceptionally good in the United Kingdom, despite a slightly lower rate of imports. Arrivals of foreign ore in February were 1,112,643 tons, against 1,293,403 tons in January a year ago. Imports in the first two months of the year totalled 2,542,269 tons, as compared with 2,646,496 tons in the corresponding period of 1960. The early months of the year are, of course, normally the quietest time for the ore trade and higher shipments are expected when the ice-bound ports of Canada and Sweden are freed.

Aluminium.—Appropriately enough, considering that just now the aluminium industry is busy celebrating the 75th anniversary of the Hall-Herault electrolytic production process, new aluminium production methods were in the news in March. Olin Mathieson, the American chemical and aluminium group, came up with a claim towards the end of March that it had developed an economically feasible method for extracting alumina from clay, rather than from bauxite as at present. To verify its work so far it said it was prepared to spend liberally. Details of the method are still somewhat lacking, but from all accounts it appears to be not unlike a process claimed last year by another United States concern—the North American Coal Co.—for producing alumina from coal waste. Both are said to involve treating the raw material with sulphuric acid to obtain aluminium sulphate and then converting the latter to alumina after it has been separated from the clay or coal waste.

So far, however, despite Olin Mathieson's assertion that the process gives material at a cost comparable with that of alumina prepared from bauxite by the usual means, it seems that there has been little reaction from the aluminium industry generally. It may be that when other firms have had a chance to study the patents acquired by Olin the story will be different, but in such a cost-conscious industry as the aluminium industry now is—particularly in view of the strong competition being experienced at the present time by all the major producers—it is apparently not without significance that other similar processes, including that worked out by Anaconda a few years ago, have also met with little or no reaction. It is true that Anaconda's process is still only in the pilot-plant stage, but it has been described by the company as satisfactory.

What, it seems, is needed, however, it not another means of getting alumina at much the same price as at present or only a little cheaper, but rather one that will give substantial savings on present bauxite-processing costs. If that is what the new Olin process finally proves to do then the industry might take more notice, but much will obviously depend on the results of efforts now being made separately by Aluminium, Ltd., in Canada and combined Pechiney-Ugine interests in France to prove their own individual processes to manufacture primary metal direct from bauxite. Should either or both succeed then most people in the industry feel that the future will be in such methods. Certainly so far as the process now being studied by Aluminium, Ltd., is concerned the prospects are attractive in that it is believed to offer substantial savings in both capital and production costs. In fact, one source within the Alcan orbit has been quoted recently as saying that its adoption may mean that the price of the final metal to the consumer can be reduced by as much as 15%.

Antimony.—The antimony ore market, which has been firm—indeed strong—since the closing stages of last year, was again strong in March and midway through the month basis 60% sulphide ore was fetching up to 28s. per long ton unit c.i.f. Europe. Previously the highest value reported was 27s. per unit. Continental consumers have again been showing interest in recent weeks, although perhaps not quite so much as before, but much of the weight of demand lately seems to have emanated from further afield—namely, India, Japan, and the United States.

In this country, where Associated Lead Manufacturers (the sole domestic antimony regulus producer) has its own long-term supply contracts with the Consolidated Murchison group in South Africa, the price commanded by open-market ore was not so high, because of the limited nature of the company's needs, but, even so, there was evidence of its having to pay rather

higher prices than it is normally accustomed to doing. This raises the possibility of higher domestic antimony regulus prices before long, but up to the time of writing nothing has been heard officially. At present 99% regulus, delivered, is quoted at £210 per ton, while 99·6%, delivered, costs £217 10s.

Usually, offering prices for Chinese regulus in this country do not move unless there is a change in the quotation for domestic material. Recently, however, Chinese 99·6% regulus was raised £2 per metric ton so far as the offering price to U.K. consumers was concerned. This rise was apparently a result of the stronger ore market, but all the evidence points to actual business still being done at somewhat below the official price of £166–£168 per metric ton, c.i.f. (excluding duty).

Arsenic.—There were no new developments in the arsenic market in March. The price for the metal is still £400 per ton, while arsenic troxide is still quoted at £40–£45 per ton.

Bismuth.—The bismuth market continues to show no change and the metal at the end of March was still quoted at a nominal 16s. per lb. ex-warehouse for one-ton lots.

Cobalt.—From the price angle cobalt was an unchanged market again in March, with open-market material still quoted at 12s. per lb. The other regular quotations (U.K. contract price for metal and black and grey oxides delivered U.K.) were also unchanged again at 10s. 9d., 7s. 10d., and 8s. 4d. per lb., respectively.

Any remaining fears of a possible coming shortage of cobalt as a result of the Congo disturbances were dealt with in March with the publication of a review of cobalt in 1960 by the Cobalt Information Centre in Brussels. While 1960 production outside the communist bloc did not quite come up to the previous high level attained in 1959 (it was in fact only 16,800 short tons, against some 17,500 tons the previous year) the shortfall was attributed mainly to the United States and Northern Rhodesia. In the former case, the Cobalt Information Centre states, 1960 was the first time the full impact of the closure of the Calera Mining Co.'s facilities was felt. As for Rhodesia the ore treated was of lower grade than before. Production in Katanga, however, was near normal, the political events there having had practically no effect on Union Minière's operations.

For the future higher output is expected and not the least contributory factor will be the starting of operations later this year at Union Minière's new 4,000-ton-per-year electrolytic plant at Luilu.

Cadmium.—Cadmium was an uneventful market in March and quotations were again unchanged throughout at 11s. per lb. for U.K. and Empire metal 99·9%, in one-cwt. lots, and 10s. 9d.–11s. per lb. delivered, duty paid, for foreign.

Chromium.—Chromium metal prices were unchanged throughout March at 6s. 11d.–7s. 4d. per lb.

Tantalum.—There were no new developments in the tantalite market in March and prices again held steady throughout at 1,000s.–1,200s. per unit for ore assaying 60% Ta_2O_5.

Platinum.—As for many months past interest in platinum, whether from Commonwealth or open-market sources, was chiefly conspicuous for its absence during March and prices of both types of metal were once more unchanged at £30 5s. and £27 10s.–£28 5s., respectively, per troy oz. The lack of expanded interest in Commonwealth material in past months was reflected recently in news from Rustenburg Platinum Mines, in South Africa, that with the rate of production continuing in excess of the estimated annual level of sales it will eventually have to be reduced as stocks rise to the desired levels.

Iridium.—Iridium sponge and powder continued to be quoted at £20–£26 15s. per troy oz. during March.

Palladium.—Interest in palladium metal continued at a low ebb during March and prices were again unchanged at £8 10s.–£9 7s. 6d. per troy oz.

Osmium.—The quotation for osmium in March remained throughout at £17–£25 per troy oz.

Tellurium.—There was no change in the published quotation for tellurium in March. Tellurium sticks (minimum 99·5% purity) were again listed at 40s. per lb., while tellurium lump and powder was priced once more at 28s. 6d. per lb.

Tungsten.—Activity in the tungsten-ore market in March was more marked than for some time past, but despite the fact that Russian and East European ore, cheap sales of which have been progressively weakening the market for some months, was hardly traded at all (and certainly not after the first few days of the month) prices generally continued to drift down. Towards the end of the month, with many consumers apparently right out of material and having to buy to satisfy their immediate needs, most prices realized were still only around the 120s. mark, although one or two consumers were prepared to pay rather more for good-quality material delivered quickly. At the month-end

the published range stood at 118s.–123s. per long ton unit c.i.f. Europe.

Nickel.—Nickel was in the news from the market point of view in March with the publication of the International Nickel Co. of Canada's 1960 report, which forecast demand in the first half of this year as about equal to the average monthly rate of demand in the latter half of 1960—*i.e.*, about 10% under that for the whole of 1960. The report went on: "European demand continues strong. The looked-for improvement in United States demand, particularly from the steel industry, has not yet come about but we expect it will during the year. For the entire year, our present view is that we are likely to deliver as much nickel produced from our own plants as we delivered in 1960, as well as a substantial quantity of nickel which we have acquired under arrangements lessening the United States Government's accumulations of surplus nickel."

Inco also had something to say about its new Thompson, Manitoba, project, which was only officially inaugurated on March 25. With it, it claims, it is embarking on a new and (it hopes) prosperous future. All the Manitoba output, the company says, must be sold outside Canada to supply the markets it has built, and is still building, in the U.S.A., Europe, and elsewhere. Nickel is still quoted at £600 per ton, delivered.

Chrome Ore.—Activity in the chrome-ore market has continued at a routine rate in recent weeks, most deliveries now being on the basis of long-standing contracts. Published prices showed no improvement in March with Turkish 48% material still listed at a nominal $33.50 per ton f.o.b. and Rhodesian metallurgical at £15 5s. per ton c.i.f.

Molybdenum.—The market for molybdenite showed no new features in March and, with the slightly tighter supply position of February now a thing of the past, there has been no change in the prices of Climax or other material. The former is still listed at 8s. 11d. per lb. Mo contained f.o.b. mine, while ore from sources other than Climax is again quoted at 9s. 3½d. per lb. c.i.f.

Manganese Ore.—March was another month in which business in manganese ore was singularly lacking, but there is still no sign of any easing in sellers' offering prices. Generally, the most competitive offers have again been around 71d. per unit of metal contained c.i.f. Europe. However, possible consumers are equally rigid in their ideas of what would be a more realistic price to pay and the majority of them still favour about 68d.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum, 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98% per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Mar. 9	807 0	809 5	224 17½	226 7½	65 11¼	66 13¾	84 12½	83 8¾
10	807 10	810 5	224 2½	225 17½	65 11¼	66 13¾	85 3¾	83 16¼
13	812 0	813 10	223 12½	225 5	65 16¼	67 1¼	86 7½	84 8¾
14	820 0	820 10	223 10	224 17½	66 8¾	67 13¾	86 11¼	84 13¾
15	821 0	822 10	223 15	225 2½	66 15	67 18¾	86 15	84 13¾
16	815 10	817 10	224 2½	225 12½	66 18¾	68 1¼	86 6¼	84 8¾
17	817 10	818 15	225 7½	226 17½	67 6¼	68 11¼	85 13¾	84 6¼
20	821 10	823 5	227 12½	228 17½	67 3¾	68 8¾	84 13¾	83 12½
21	821 10	822 15	227 7½	228 7½	67 2½	68 8¾	83 18¾	83 2½
22	820 0	821 15	224 17½	226 7½	66 12½	67 18¾	83 8¾	83 3¾
23	824 0	826 5	226 5	227 12½	67 3¾	68 8¾	84 12½	83 17½
24	825 10	827 5	226 17½	228 7½	67 8¾	68 11¼	84 10	83 16¼
27	822 0	825 5	225 2½	226 17½	66 12½	67 17½	82 12½	82 8¾
28	820 10	824 15	223 12½	225 7½	64 17½	66 6¼	82 6¼	82 3¾
29	824 0	827 5	224 5	226 7½	65 8¾	66 16¼	83 11¼	83 3¾
30	825 0	827 15	224 12½	226 12½	65 13¾	66 16¼	83 13¾	83 8¾
31	—	—	—	—	—	—	—	—
Apr. 3	—	—	—	—	—	—	—	—
4	824 10	826 15	225 12½	227 12½	65 15	67 0	84 2½	83 17½
5	824 0	826 15	226 2½	227 12½	66 3¾	67 3¾	84 13¾	84 2½
6	828 10	830 15	226 12½	228 2½	66 11¼	67 11¼	84 6¼	84 1¼
7	831 10	834 10	228 7½	229 2½	67 1¼	68 0	83 11¼	83 8¾
10	836 10	840 0	229 2½	230 2½	67 6¼	68 7½	84 6¼	84 1¼

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	February		March	
	Treated Tons	Yield Oz.*	Treated Tons	Yield Oz.†
Blyvooruitzicht	127,000	82,391	139,000	90,002
Brakpan	137,000	17,000	142,000	18,019
Buffelsfontein‡	148,000	65,419	150,000	66,028
City Deep	105,000	21,990	113,000	23,690
Cons. Main Reef	46,000	9,765	48,000	10,048
Crown Mines	177,000	30,876	193,000	33,326
Daggafontein	200,000	44,534	229,000	46,324
Dominion Reef	41,000	485	47,700	548
Doornfontein‡	110,000	46,206	115,000	47,530
D'rb'n Roodeport Deep	177,000	32,701	193,000	35,622
East Champ D'Or‡	12,000	275	12,500	291
East Daggafontein	104,500	17,870	108,000	18,460
East Geduld	125,000	35,938	130,000	37,050
East Rand P.M.	224,000	49,491	235,000	52,324
Eastern Transvaal Consol	18,500	5,910	19,000	5,711
Ellaton‡	25,000	5,859	25,000	5,862
Freddies Consol.	59,000	13,047	64,000	13,529
Free State Geduld	95,000	83,173	97,000	84,747
Free State Saaiplaas	50,000	11,696	53,500	14,002
Geduld	75,000	12,001	80,000	12,406
Government G.M. Areas‡	44,000	9,187	42,000	9,244
Grootvlei Proprietary	210,000	43,472	215,000	44,537
Harmony Gold Mining	172,000	70,086	186,000	75,808
Hartebeestfontein‡	126,000	58,275	131,000	60,260
Libanon	117,000	28,498	117,000	28,542
Loraine	81,000	20,655	82,000	21,730
Luipaards Vlei‡	110,000	13,125	114,000	13,491
Marievale Consolidated	92,000	22,402	99,000	23,859
Modderfontein East	54,000	6,109	59,000	6,568
New Kleinfontein	70,000	9,566	75,000	10,324
New Klerksdorp‡	10,200	1,380	9,600	1,294
President Brand	118,000	93,227	123,000	96,533
President Steyn	106,000	39,712	108,000	40,533
Rand Leases	176,000	24,024	194,000	26,481
Randfontein‡	152,000	10,401	164,000	10,264
Rietfontein Consolid't'd.	12,000	3,240	12,000	3,276
Robinson Deep	34,000	9,358	42,500	9,643
Rose Deep	21,000	3,958	23,000	4,216
St. Helena Gold Mines	170,000	59,935	182,000	64,155
Simmer and Jack	70,000	12,448	69,000	12,728
S. African Land and Ex.	102,500	20,827	107,000	21,583
S. Roodepoort M.R.	26,000	6,431	29,000	6,955
Spaarwater Gold	10,900	3,633	11,200	3,580
Springs	90,500	12,584	94,000	12,967
Stilfontein Gold Mining‡	171,000	78,300	175,000	79,400
Sub Nigel	64,000	14,723	66,500	15,026
Transvaal G.M. Estates	—	—	—	—
Vaal Reefs‡	100,000	46,501	105,500	49,057
Van Dyk Consolidated	70,000	11,372	73,000	11,632
Venterspost Gold	117,000	34,041	125,000	36,263
Village Main Reef	31,500	4,095	35,600	4,110
Virginia O.F.S.‡	123,000	26,420	130,000	26,767
Vlakfontein	50,000	18,546	52,500	19,428
Vogelstruisbult‡	79,000	17,031	81,000	17,322
Welkom Gold Mining	95,000	29,847	99,000	31,410
West Driefontein‡	130,000	121,577	130,000	121,614
West Rand Consol.‡	199,000	19,665	218,000	22,396
Western Holdings	160,000	110,001	170,000	116,875
Western Reefs	140,000	40,601	150,000	43,501
Winkelhaak	90,000	30,826	94,000	31,961
Witwatersrand Nigel	19,400	4,204	19,900	4,272

† 253s. 3d. * 250s. 7d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION*

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Dec., 1959	17,670,000	72 2	45 10	26 4	30,559,937
Jan., 1960	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,464,400	72 8	46 5	26 3	30,105,571
April	—	—	—	—	—
May	—	—	—	—	—
June	17,968,300	73 9	46 3	27 6	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept	18,103,100	74 0	46 4	27 8	32,201,685
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,272,800	76 2	47 0	29 2	33,039,583

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
March, 1960	1,664,514	38,744	1,703,258
April	1,734,310	36,720	1,771,030
May	1,765,880	37,897	1,803,777
June	1,775,335	37,530	1,812,865
July	1,776,141	39,673	1,815,814
August	1,778,711	36,777	1,815,488
September	1,774,967	35,352	1,810,319
October	1,777,495	35,967	1,813,462
November	1,775,624	36,159	1,811,783
December	1,744,406	34,044	1,778,450
January, 1961	1,785,614	34,407	1,820,021
February	1,759,373	32,046	1,791,419

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
June 30, 1960	380,593	31,435	412,028
July 31	378,626	31,879	410,505
August 31	374,303	32,321	406,624
September 30	369,751	32,996	402,747
October 31	368,391	33,387	401,778
November 30	367,658	33,052	400,710
December 31	364,407	32,791	397,198
January 31, 1961	384,816	33,513	418,329
February 28	396,533	33,577	430,110

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Mar. 4		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	22,900	3,516	4,180
Electrolytic Zinc	—	—	—
Lake George	15,418	1,167	2,387
Mount Isa Mines**	63,194	4,380†	5,246
New Broken Hill	55,470	6,815	14,645
North Broken Hill	31,198	5,902	6,649
Zinc Corp.	64,030	9,301	11,855
Rhodesia Broken Hill*	—	3,810†	7,431†

*3 Months, ** Copper 3,475 tons blister; 6,536 tons concs.; † Metal.

RHODESIAN GOLD OUTPUTS

	February		March	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	22,100	4,365	22,500	4,384
Globe and Phœnix	6,050	2,836	4,920	3,052
Motapa Gold Mining	—	—	—	—
Mazoe	2,628	—	2,615	—
Coronation Syndicate	11,802	—	11,732	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	February		March	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	34,257	9,318	37,849	8,507
Ariston Gold Mines	35,000	10,837	35,500	11,421
Ashanti Goldfields	38,500	32,750	38,500	32,000
Bibiani	26,000	5,690	27,000	5,570
Bremang	—	4,106	—	4,954
Ghana Main Reef	10,881	4,403	11,607	4,388
Konongo	7,220	3,680	7,610	3,675
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1959		1960	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	46,489	18,077	44,902	29,711
February	43,366	19,806	45,754	29,865
March	48,397	17,394	45,309	29,656
April	46,315	5,694	48,607	6,847
May	46,423	46,280	47,542	62,912
June	49,995	31,386	45,884	34,298
July	46,512	32,734	44,865	33,323
August	38,727	29,178	48,284	28,931
September	56,760	33,837	48,805	38,951
October	48,528	32,314	47,473	37,308
November	47,916	31,092	46,439	33,896
December	47,452	31,175	48,778	26,327

WESTRALIAN GOLD PRODUCTION

	1959	1960	1961
	Oz.	Oz.	Oz.
January	63,924	64,794	62,434
February	65,035	66,789	73,271
March	65,408	61,941	—
April	62,686	65,373	—
May	64,184	66,682	—
June	74,590	74,902	—
July	78,974	67,623	—
August	68,546	67,406	—
September	66,501	68,794	—
October	70,427	67,310	—
November	68,858	107,815	—
December	117,474	76,269	—
Total	861,122	855,758	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Jan. 31		To Feb. 28	
	Tons	Oz.	Tons	Oz.
Central Norseman	13,981	8,048	14,193	8,666
Gold Mines of Kalgoorlie	35,178	12,217	41,432	13,199
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	31,985	4,519	32,388	4,749
Lake View and Star*	—	—	—	—
North Kalgurli	28,501	7,469	—	—
Sons of Gwalia	18,594	3,922	11,606	2,464
Mount Morgan	—	3,515	—	3,729

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
October, 1959	794,030	227,192	34,733	7,558,567
November	770,437	227,176	35,202	7,600,949
December	775,803	221,377	40,807	7,388,654
January, 1960	778,103	226,856	27,617	7,550,068
February	755,569	222,484	35,003	7,446,848
March	804,309	229,457	37,202	7,646,044
April	779,487	218,393	42,997	7,426,202
May	784,391	225,550	32,174	7,765,153
June	791,488	223,833	49,765	7,756,490
July	779,426	222,179	37,002	7,664,968
August	712,792	202,025	35,722	6,883,254
September	772,984	208,019	29,251	7,114,785
October	805,753	228,914	33,808	7,860,787
November	785,133	230,377	31,149	7,917,352
December	783,501	229,639	37,560	8,020,961
January, 1961	804,026	227,771	28,776	7,901,743

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	February		March	
	Tons	Oz.	Tons	Oz.
Clutha River	—	697	—	925
Lampa (Peru)†	—	34,060	—	—
New Guinea Goldfields	3,253	1,715	—	—
Yukon Consol.	—	—	—	—

† Oz. Silver: Copper, 141 tons; 110 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (*a*)	Lead
1959	246,693	89,162	305,163
Provisional			
1959—January	12,946	7,744	14,874
February	23,658	8,493	26,361
March	27,377	9,776	30,402
April	82,992	8,142	23,477
May	25,122	9,400	26,832
June	27,786	10,087	29,298
July	17,570	10,351	19,861
August	25,115	9,757	26,247
September	28,671	9,088	29,333
October	28,923	8,701	28,133
November	30,739	8,480	29,836
December	19,697	7,989	19,374

(*a*) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Jan.	Feb.	Mar.
Ampat Tin	70	33	35
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Berjuntai	247	216½	258
Chenderiang	—	—	—
Gopeng Consolidated	—	—	—
Hong Fatt (Sungei Besi)	—	—	—
Hongkong Tin	—	—	—
Idris Hydraulic	—	—	—
Ipoh	13	18	11½
Kampong Lanjut	190½	92	99
Kamunting	116	107½	144
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	—	—
Kinta Kellas	15½	16	13½
Kramat	45½	48	44½
Kuala Kampar	143	137	131
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Larut	39	19	30
Lower Perak	58	120	122½
Malayan	—	—	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	—	634*
Pengkalen	—	—	—
Petaling Tin	—	—	396*
Rahman Hydraulic	—	—	—
Rambutan	—	—	—
Rantau	63	52½	59½
Renong	—	—	215½*
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	57	44	50
Southern Kinta	345	343	378
Southern Malayan	—	—	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	—	—	—
Tanjong	—	—	—
Tekka	—	—	—
Temoh	—	—	—
Tongkah Harbour	153	117	172½
Tronoh	—	—	—

* 3 Months.

NIGERIAN MINE OUTPUTS (TONS)

	Dec.	Jan.
Cassiterite	924	866
Columbite	200	160
Felspar	—	—
Gold*	69	79
Kaolin	2	—
Lead Ore	15	8
Limestone	30,302	49,710
Monazite	1	1
Tantalite	18	1
Thorite	1	—
Wolfram	—	—
Zinc	—	—
Zircon	158	176

* Oz.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Feb.		Mar.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	376	65	461	—
Anglo-Burma Tin*	—	—	—	—
Bangrin	41	—	43	—
Beralt	3	175†	3	184†
Bisichi	57½	32½	—	—
Ex-Lands Nigeria	45	—	40	—
Fabulosa	46	—	59	—
Geevor	56	—	—	—
Gold and Base Metal	67	4	67	3
Jantar Nigeria	19	36	19	30
Jos Tin	—	—	—	—
Kaduna Prospectors	6½	—	6	—
Kaduna Syndicate	21	—	22	—
Katu Tin	8	—	6	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	—	—	—	—
Naraguta Tin	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	86	—	104	—
South Bukeru	—	—	—	—
South Crofty	74	—	78	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	16	½	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

January, 1961.

Gold	1,820,502 oz.
Silver	185,953 oz.
Diamonds	616,414 carats *
Coal	3,579,681 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 4,913 tons of 99·16%.
Tin	227 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	14,997 tons.
Chrome Ore	69,660 tons.
Manganese Ore	111,655 tons.
Lead Concs.	— tons.

* *December, 1960.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Jan.	Feb.
Iron Ore	tons	1,429,626	1,112,643
Manganese Ore	„	55,703	43,206
Iron and Steel	„	84,928	65,395
Iron Pyrites	„	24,910	9,070
Copper Metal	„	50,151	38,736
Tin Ore	„	2,140	4,534
Tin Metal	„	376	80
Lead	„	18,252	11,266
Zinc Ore and Conc.	„	27,274	2,527
Zinc	„	17,172	11,217
Tungsten Ores	„	770	499
Chrome Ore	„	16,047	45,846
Bauxite	„	49,925	39,247
Antimony Ore and Concs.	„	1,296	1,151
Titanium Ore	„	37,002	23,246
Zirconium Ores and Concs	„	2,726	3,059
Tantalite/Columbite	„	96	4
Sulphur	„	47,239	39,369
Barytes	„	3,628	5,706
Asbestos	„	14,177	8,006
Magnesite	„	14,753	9,904
Mica	„	622	594
Graphite	„	631	823
Mineral Phosphates	„	115,903	110,761
Molybdenum Ore	„	587	1,060
Silicon	„	662	527
Nickel	cwt.	81,760	54,630
Aluminium	„	594,517	464,644
Mercury	lb.	180,567	271,394
Bismuth	„	132,567	81,816
Cadmium	„	255,700	234,477
Cobalt and Cobalt Alloys	„	167,306	360,859
Selenium	„	18,339	24,671
Petroleum Crude	1,000 gal.	1,218,466	1,011,938

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	104	0	0
„ „ 80% Technical	„	90	0	0
Alum, Comml.	„	25	0	0
Aluminium Sulphate	„	16	5	0
Ammonia, Anhydrous	per lb.		1	6
Ammonium Carbonate	per ton	59	0	0
„ Chloride,	„	30	2	6
„ Nitrate	„	36	5	0
Antimony Sulphide, golden	per lb.		4	4
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate 98–99%	„	42	0	0
„ Chloride	„	45	0	0
Barytes (Bleached)	„	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	„	46	10	0
Boric Acid, Comml.	„	77	10	0
Calcium Carbide	„	40	17	9
„ Chloride, solid, 70/75%	„	17	0	0
Carbolic Acid, crystals	per lb.		1	3
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	9	17	0
Copper Sulphate	per ton	77	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	„		7	10
Hydrochloric Acid 28° Tw.	per carboy		13	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iodine	per kilo		17	4
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	„	112	5	0
„ Nitrate	„	110	0	0
„ Oxide, Litharge	„	101	5	0
„ Red	„	99	5	0
Lime Acetate, brown	„	40	0	0
Lithopone	„	57	10	0
Magnesite, Calcined	„	20	0	0
„ Raw	„	13	0	0
Magnesium Chloride	„	20	0	0
„ Sulphate, Comml.	„	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	1
Nickel Sulphate	per ton	189	0	0
Nitric Acid, 70° Tw.	„	35	0	0
Oxalic Acid	„	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	„		1	2½
„ Bromide	„		2	6
„ Carbonate (hydrated)	per ton	72	10	0
„ Chloride	„	21	0	0
„ Iodide	per kilo		19	3
„ Hydrate (Caustic) solid	per ton	92	0	0
„ Nitrate	per cwt.	3	10	0
„ Permanganate	per ton	198	0	0
„ Sulphate, 50%	„	21	1	0
Sodium Acetate	„	63	0	0
„ Arsenate, 58–60%	„	Nominal		
„ Bicarbonate	„	18	0	0
„ Bichromate	per lb.		1	0
„ Carbonate (Soda Ash) 58%	„	16	0	0
„ Chlorate	per ton	90	0	0
„ Cyanide	per cwt.	6	18	10
„ Hydrate, 76/77%, solid	per ton	33	0	0
„ Hyposulphite, Comml.	„	35	0	0
„ Nitrate, Comml.	„	Nominal		
„ Phosphate (Dibasic)	„	40	10	0
„ Prussiate	per lb.		1	0½
„ Silicate	per ton	11	10	0
„ Sulphate (Glauber's Salt)	„	12	5	0
„ „ (Salt-Cake)	„	10	0	0
„ Sulphide, flakes, 60/62%	„	38	12	6
„ Sulphite, Comml.	„	27	15	0
Sulphur, American, Rock (Truckload)	„	13	0	0
„ Ground, Crude	„	17	10	0
Sulphuric Acid, 168° Tw.	„	12	0	0
„ „ free from Arsenic, 140° Tw.	„	8	10	0
Superphosphate of Lime, 18% P_2O_5	„	13	15	0
Tin Oxide	„	Nominal		
Titanium Oxide, Rutile	„	172	0	0
„ White, 25%	„	85	0	0
Zinc Chloride	„	95	0	0
„ Dust, 95/97% (4-ton lots)	„	125	0	0
„ Oxide	„	95	0	0
„ Sulphate	„	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Mar. 8, 1961 £ s. d.	Apr. 10, 1961 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 15 0	1 19 6
Blyvooruitzicht (2s. 6d.)	1 8 0	1 3 6
Bracken (10s.)	1 8 6	19 6
Brakpan (3d.)	4 0	3 3
Buffelsfontein (10s.)	2 0 6	1 12 6
City Deep	16 6	12 3
Consolidated Main Reef	13 0	12 6
Crown Mines (10s.)	1 3 6	19 6
Daggafontein (5s.)	1 1 3	18 6
Dominion Reefs (5s.)	1 1 0	18 0
Doornfontein (10s.)	1 9 3	1 3 0
Durban Roodepoort Deep (10s.)	1 8 3	1 3 6
East Champ d'Or (2s. 6d.)	1 9	1 6
East Daggafontein (10s.)	8 6	7 6
East Geduld (4s.)	18 3	16 0
East Rand Ext. (5s.)	17 6	14 3
East Rand Proprietary (10s.)	1 11 3	1 5 0
Freddies Consol.	1 9	1 0
Free State Dev. (5s.)	5 3	3 9
Free State Geduld (5s.)	5 10 6	4 7 6
Free State Saaiplaas (10s.)	8 0	5 6
Geduld	2 12 6	1 18 9
Government Gold Mining Areas (3d.)	2 6	2 0
Grootvlei (5s.)	1 0 0	15 0
Harmony (5s.)	1 8 0	1 2 6
Hartebeestfontein (10s.)	2 10 6	2 3 9
Libanon (10s.)	14 3	10 0
Loraine (10s.)	1 7 6	16 3
Luipaards Vlei (2s.)	8 6	7 6
Marievale (10s.)	1 8 3	1 3 0
Modderfontein B (3d.)	1 6	1 6
Modderfontein East	10 6	9 0
New Kleinfontein	4 0	3 6
New Pioneer (5s.)	1 10 3	1 5 0
New State Areas (15s. 6d.)	9	6
President Brand (5s.)	2 17 6	2 6 3
President Steyn (5s.)	19 9	15 9
Rand Leases (9s. 3d.)	5 9	4 3
Randfontein	1 1 6	18 0
Rietfontein (3d.)	2 6	2 6
Robinson Deep (5s. 6d.)	4 6	3 6
Rose Deep (3d.)	6 0	5 6
St. Helena (10s.)	3 8 9	2 12 3
Simmer and Jack (1s. 6d.)	1 6	1 0
South African Land (3s. 6d.)	15 3	13 9
Springs (3d.)	1 3	1 0
Stilfontein (5s.)	1 13 0	1 7 6
Sub Nigel (3d.)	8 9	7 3
Vaal Reefs (5s.)	2 2 0	1 13 9
Van Dyk (3d.)	2 3	2 3
Venterspost (10s.)	1 0 6	15 6
Virginia (5s.)	3 6	3 0
Vlakfontein (10s.)	17 3	14 0
Vogelstruisbult (3d.)	5 0	4 0
Welkom (5s.)	17 0	12 3
West Driefontein (10s.)	4 11 9	3 12 6
West Rand Consolidated (10s.)	17 6	16 9
West Witwatersrand Areas (2s. 6d.)	3 5 3	2 8 9
Western Holdings (5s.)	6 16 3	5 13 9
Western Reefs (5s.)	1 7 3	1 3 0
Winkelhaak (10s.)	1 6 0	18 0
Witwatersrand Nigel (2s. 6d.)	1 0	9
Zandpan (10s.)	11 6	9 0
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	13 9	13 9
Coronation (2s. 6d.)	4 9	4 6
Falcon (5s.)	8 9	7 9
Globe and Phœnix (5s.)	1 12 6	1 13 0
Motapa (5s.)	—	—
GHANA:		
Amalgamated Banket (3s.)	9	9
Ariston Gold (3s. 6d.)	3 9	3 9
Ashanti Goldfields (4s.)	13 3	13 6
Bibiani (4s.)	3 9	3 9
Bremang Gold Dredging (5s.)	3 6	3 6
Ghana Main Reef (5s.)	2 9	2 9
Konongo (2s.)	1 0	1 0
Kwahu (2s.)	4 9	4 6
Offin River (2s. 6d.)	2 0	2 0
Western Selection (5s.)	4 6	4 9
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 6	1 6
Gold Mines of Kalgoorlie (10s.)	8 0	7 6
Great Boulder Propriet'y (2s.), W.A.	12 6	12 3
Lake View and Star (4s.), W.A.	1 5 6	1 4 9
Mount Morgan (10s.), Q.	12 9	12 0
New Guinea Gold (4s. 3d.)	1 3	1 3
North Kalgurli (1912) (2s.), W.A.	9 9	9 9
Sons of Gwalia (10s.), W.A.	2 9	3 0
Western Mining (5s.), W.A.	9 9	10 0

	Mar. 8, 1961 £ s. d.	Apr. 10, 1961 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 6 3	1 6 3
Kentan Gold Areas	19 9	19 3
St. John d'el Rey, Brazil	5 10 0	5 15 0
Yukon Consolidated ($1)	4 0	3 10½
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	13 9	13 6
Esperanza (2s. 6d.), Cyprus	1 3	1 3
Indian (2s.)	5 3	6 0
MTD (Mangula) (5s.)	7 0	7 0
Messina (5s.), Transvaal	16 0	14 9
Mount Lyell (5s.), Tasmania	5 0	4 9
Nchanga Consolidated, N. Rhodesia	2 4 3	2 6 0
Rhokana Corporation, N. Rhodesia	2 2 0	2 2 0
Roan Antelope (5s.), N. Rhodesia	5 3	5 3
Tanganyika Concessions (10s.)	1 5 3	1 6 6
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	8 9	9 3
Burma Mines (3s. 6d.)	1 0	1 0
Consol. Zinc Corp. Ord.	3 9 6	3 16 0
Lake George (5s.), N.S.W.	5 9	5 6
Mount Isa, Queensland (5s. Aust.)	2 6 3	2 7 0
New Broken Hill (5s.), N.S.W.	2 2 0	2 2 0
North Broken Hill (10s.), N.S.W.	14 6	14 0
Rhodesia Broken Hill (5s.)	6 6	6 9
San Francisco (10s.), Mexico	15 3	14 0
TIN:		
Amalgamated Tin (5s.), Nigeria	10 0	11 0
Ampat (4s.), Malaya	12 9	14 3
Ayer Hitam (5s.), Malaya	1 9 9	1 16 6
Beralt (5s.), Portugal	1 8 9	1 7 3
Bisichi (2s. 6d.), Nigeria	5 9	5 6
Ex-Lands (2s.), Nigeria	3 6	3 6
Geevor (5s.), Cornwall	1 1 0	1 1 3
Gold Base Metals (2s. 6d.), Nigeria	1 9	2 0
Hongkong (5s.), Malaya	12 9	1 5 0
Jantar Nigeria (3s.)	5 6	5 6
Kaduna Syndicate (2s.), Nigeria	2 3	2 3
Kamunting (5s.), Malaya	17 0	17 0
Malayan Tin Dredging (5s.)	1 6 6	1 10 6
Mawchi Mines (4s.), Burma	1 3	1 3
Naraguta Karama (5s.), Nigeria	1 3	1 3
Pahang (5s.), Malaya	11 6	12 3
Siamese Synd. (5s.)	15 6	16 6
South Crofty (5s.), Cornwall	4 0	4 0
Southern Kinta (5s.), Malaya	1 9 3	1 13 6
Southern Malayan (5s.)	1 6 9	1 14 0
Sungei Besi (4s.), Malaya	1 8 9	1 13 9
Sungei Kinta, Malaya	18 0	18 3
Sungei Way (2s. 4d.), Malaya	4 9	4 9
Temoh (7s. 6d.), Malaya	4 6	4 3
Tronoh (5s.), Malaya	2 4 0	2 6 6
United Tin Areas (2s. 6d.), Nigeria	1 4½	1 3
DIAMONDS:		
Anglo American Investment	11 15 0	10 12 6
Consol African Selection Trust (5s.)	14 6	14 3
Consolidated of S.W.A. Pref. (10s.)	10 0	9 6
De Beers Deferred (5s.)	7 10 6	6 4 3
FINANCE, Etc.		
African & European (10s.)	3 5 0	2 18 9
Anglo American Corporation (10s.)	7 8 9	6 5 0
Anglo Transvaal 'A' (5s.)	1 13 6	1 8 6
British South Africa (15s.)	3 7 9	3 1 9
British Tin Investment (10s.)	1 17 6	2 3 9
Broken Hill Proprietary	2 12 9	2 16 6
Camp Bird (10s.)	7 3	6 6
Central Mining	3 6 6	1 6 3
Central Provinces Manganese (10s.)	1 5 6	1 4 9
Consolidated Gold Fields	2 19 3	2 6 6
Consolidated Mines Selection (10s.)	1 8 0	1 2 9
Corner House	16 0	8 3
East Rand Consolidated (5s.)	1 9	1 9
Free State Development (5s.)	5 3	3 9
General Exploration O.F.S. (2s. 6d.)	4 3	2 9
General Mining and Finance	5 7 3	4 7 6
Hendersons (4s.)	8 6	6 6
Johannesburg Consolidated	2 9 0	1 19 3
London & Rhod. M. & L. (5s.)	4 0	4 3
London Tin Corporation (4s.)	14 6	16 0
Lydenburg Est. (5s.)	12 0	9 6
Marsman Investments (10s.)	2 7½	2 7½
National Mining	2 0	2 0
Rand Mines (5s.)	3 17 6	3 6 3
Rand Selection (5s.)	2 6 6	1 12 6
Rhodesian Anglo American (10s.)	2 12 9	2 15 3
Rhodesian Corporation (5s.)	2 3	2 0
Rhodesian Selection Trust (5s.)	8 6	10 3
Rio Tinto (10s.)	1 17 3	2 1 9
Selection Trust (10s.)	4 0 0	4 7 6
South West Africa Co. (3s. 4d.)	10 0	10 0
Union Corporation (2s. 6d.)	2 16 9	2 2 9
Vereeniging	5 6 3	4 5 0
West Rand Inv. Trust (10s.)	2 13 9	2 0 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

The Beach Sands of South India

In *Science and Culture* for January there is a 50-year review of "The Beach Sands Industry in South India," by P. Viswanathan, who was formerly chief chemist with Travancore Minerals, Quilon (Kerala). The author traces the history of the exploitation of these deposits, first through the period of German control to the second phase when the British company, Travancore Minerals, took over operations in 1918. In the last-named year there was little or no demand for monazite and consequently the production and marketing of other minerals present in the monazite sands were undertaken. Ilmenite from Manavalakurichi found a ready market and increased production of ilmenite naturally involved increased consumption of raw material and a corresponding increase in tailings containing valuable rare minerals, zircon, rutile, sillimanite, and monazite. Efforts were directed to standardize flowsheets for the recovery of all these minerals and the tailings from the ilmenite plant on being run over wet tables yielded two cuts almost free from quartz. All the monazite was concentrated in the heaviest fraction and was stockpiled for use, as and when necessary. The middle fraction containing ilmenite, rutile, and zircon was dressed to yield very high grades of zircon and rutile. A pilot froth-flotation plant was installed in 1934 for the effective separation of rutile from zircon and this proved to be very effective. When floated concentrates were dried and tabled, greenish tinged sillimanite was noticed and that is how sillimanite came to be discovered. The new flotation process helped to produce zircon of over 99·5% purity containing only one-tenth of 1% rutile.

In 1938 the company installed a pilot plant for the concentration of rutile by electrostatic process. Two grades of rutile were produced—ceramic grade of 96+ titanium oxide and metallurgical grade of 92+ titanium oxide. Production during the war years exceeded 8,000 tons and the entire quantity went to the British Ministry of Supply in London. As shipments of ilmenite had ceased during the war it was production of rutile that averted a shut-down of all the plants.

With the termination of the second world war ilmenite shipments were resumed. Another change in the structure of the mining companies came into being. There had been little or no control over the mining and dressing operations by the State. In 1946, however, all the operating companies signed a mining agency agreement by which the companies were to continue their operations as agents of Government.

One of the major consumers of Indian ilmenite—British Titan Products—agreed to install a plant in the State of Travancore for the manufacture of titanium dioxide from the indigenous ilmenite. As a result, the Travancore Titanium Products at Trivandrum came into being. This plant now produces 10 tons of titanium dioxide per day and plans are afoot to double this capacity.

The first move to bring the industry fully into the public sector was taken in June, 1949, when the oldest producer, Travancore Minerals Company, was purchased by the State. Two years later another producer, Associated Mineral Company, was also purchased and merged with the State-owned Travancore Minerals Private, Ltd., directed by a Board of representatives of the Governments of India, Madras, and Kerala. The overall control of the activities is exercised by the Department of Atomic Energy, Government of India. Hopkin and Williams, a private company, still continues to operate in the private sector and F. X. Pereira and Sons is managed by the Government of Kerala.

In order to conserve the nation's reserves of monazite the Department of Atomic Energy, Government of India, has specified that the maximum monazite content in ilmenite produced for export should not exceed 0·10% and the export of monazite as such was totally banned. This specification was fixed without an actual

study of the methods of concentrating ilmenite and so its implementation had the immediate effect of reducing production, as well as reducing the recovery of ilmenite from feeds.

The raw sand feeds contain monazite varying from a trace to 3% or 4%. Even when ilmenite is concentrated on the weaker fields of lift magnets, a small percentage of monzaite is invariably entrained with ilmenite. Experience has shown that this entrainment has a direct relation to the monazite content of the feeds, other conditions remaining the same. If standard-grade ilmenite has to be produced from two different fields, one containing, say, ¼% monazite and the other, say, 3%, the recovery of ilmenite from the former may be as high as 80% whereas the same from the latter may be as low as 40%. In other words, if the monazite content of feeds runs high—as there are some sources of ilmenite which contain a high content of monazite—considerable quantities of ilmenite will pass into the non-magnetic tailings necessitating tedious re-workings of these to recover ilmenite. The most effective method of separating monazite from ilmenite is by electrostatic concentration, as monazite is a weaker conductor than ilmenite. A suitable flowsheet incorporating the use of high-tension electrostatic separators has been evolved and awaits implementation in the plants at Chavara.

Current methods of mining in Travancore are unscientific and wasteful, the author says. The method of payments for mined raw material is not based either on the tonnage of material supplied or its quality, but on the tonnage of final ilmenite produced. This encourages directly the mining of very rich seams only wherever available, leaving the poorer seams unworked. Continuous working on selected rich seams only will naturally result in the rapid depletion of rich reserves and a time may come when only the poorer seams may be left. The cost of production will then go up and, in the face of the already existing world competition to retain the existing markets, it would be a problem to maintain economic production. Unless early effective steps are taken it appears as though the industry is heading for a critical situation. Systematic mining of all available deposits and the blending of rich and poor seams is a most urgent necessity in order that the life of the deposits is preserved.

The contribution of India to world production which was 90% in 1940 has fallen to-day to less than 25%. The methods of production in India have remained more or less unchanged whereas more efficient and up-to-date methods have come into vogue in other production centres of the world and so it is obvious that unless effective measures are taken to re-organize the entire production pattern it will be very difficult to retain the existing markets for the beach minerals. Of the two plants which were operating at Manavalakurichi one is already shut down indefinitely and the other is struggling hard against a closure. The reason for this situation is that the prices for this grade of ilmenite were fixed on an unscientific basis and the consumption of monazite by the Indian Rare Earths at Alwaye has fallen steeply, as against predetermined levels. The chief factor in favour of the Indian ilmenite is its high titanium content and so the quality of the ilmenite has to be maintained at the highest level. Of late labour charges have been rising enormously, resulting in high production costs. On the other hand the Indian deposits contain the largest number of economic minerals as compared to the other world deposits and, besides, do not contain troublesome impurities like magnetite, staurolie, or tourmaline. In spite of all these natural advantages full benefits have not accrued to the nation from these gifts of nature.

Both zircon and rutile are being produced in very large tonnages in Australia, the author says. Zircon was originally being used as a super refractory. Recently interest in the metal zirconium has grown. Developments in the atomic field have added importance to this metal. Hafnium, another recent addition to the rare metals, is also present in zircon. A recent large use has opened up in the foundry industry for zircon. As moulds in the foundries zircon stands up to much higher temperatures than quartz, commonly used, and besides does not "wet" the molten metal, thus giving better definition to the castings. The moulds can be used for several castings owing to the higher refractory nature of zircon.

A serious factor which has prevented the extended use of zircon sand in foundries to advantage is its present price and the high rail freight. Foundry sands need not be of very high grade of purity; cruder products can be used and the maximum tolerance of known impurities remains to be worked out. Moreover, this material is now being supplied in expensive jute hessian bags and adds further to the already high prices. Cruder material, if transported in bulk, can result in greater consumption and extended use all over India. The situation regarding the internal consumption of rutile is rather better than that of zircon. Australian production has been responsible for a glut in the market for this material and a general fall in its

world prices. With the anticipated increase in the production of steel in India there is scope for the expansion in the production of welding rods. At present major producers in India like the Indian Oxygen and Advani-Oerlikon are finding it difficult to procure even the small tonnages of rutile from the producers. This is owing to the difficulties in the plant for maintaining a steady target of production, mainly due to manual methods of production and labour troubles. The consumers have, therefore, been compelled, much against their will, to request for import permits to acquire the material from Australia at much lower prices. Indian rutile is in no way inferior in quality and, provided adequate measures are taken to ensure steady production, there is ample scope for the expanded use of rutile within the country.

Sillimanite is yet another mineral which requires extended use within the country. It has been computed recently that refractories worth about 30 crores of rupees are being imported. It should, therefore, be possible for sillimanite to find a ready market in India's developing economy. Sillimanite of the highest grade can be produced and this finds extensive use in the form of bricks, electric insulators, spark plug cores, pyrometer sheaths, etc.

Much remains to be done in this field. Extensive and useful research initiated in this field by Travancore Minerals Co. has to be followed up with hard work, in the light of recent and ever increasing uses to which these minerals are put. If there is any industry in India which has unlimited potentialities and which has not been tapped to its maximum benefit it is the deposits of precious minerals, which nature has bestowed in extensive areas not only in South India but in many other regions spread widely over the sub-continent.

Fluidized Roasting for Sulphides

An article by W. Curlook and H. J. Roorda in the *Canadian Mining and Metallurgical Bulletin* for February gives some details of the fluid-bed roasting process developed by the International Nickel Co. of Canada, Ltd., for the continuous production of coarse granular nickel oxide from fine sulphide concentrates. In its concentrator International Nickel recovers nickel-, copper-, and iron-rich products. The main nickel product is roasted and reverberatory smelted. The furnace matte is Bessemerized and the resulting converter matte is treated by the matte separation process, which involves controlled slow cooling, grinding, and flotation. A major product of this process is a fine, relatively pure nickel sulphide, locally termed "matte separation nickel sulphide concentrate."

The major part of this concentrate is sintered on Dwight-Lloyd machines to an oxide containing about 0·5% sulphur. A substantial amount of this oxide is smelted to anode metal for electrolytic refining at Port Colborne, Ontario, and a portion is refined by the Mond carbonyl process at Clydach, Wales. Some of the nickel sulphide concentrate by-passes the sintering-smelting operations and is refined directly by the new matte electrolysis process.

Sintering of fine nickel sulphide has several inherent disadvantages. The low melting point tends to favour fusion over oxidation, thus necessitating dilution of the sulphide charge with about five times its weight of crushed sinter. The mechanical complexity, together with the excessively high temperatures involved, present maintenance problems. In addition, sintering produces a relatively dense product which is insufficiently active for certain applications. Consequently, studies aimed at development of an improved method for nickel oxide production have been in progress for some years. Flash roasting proved unattractive in pilot-plant trials, because of the low capacity per unit of roaster volume and because of difficult control. Fluid-bed roasting appeared to offer the advantages of high capacity, precise control, mechanical simplicity, and a more reactive product. However, conventional fluidization techniques could not be applied to the matte separation nickel sulphide concentrate because of its low melting temperature and extremely fine particle size. These obstacles were successfully overcome by agglomerating this material into small pellets before roasting. In this way the desired calcine product—uniformly roasted, coarsely granular, and dust-free—was produced at high throughput rates. Roasting tests, commenced in 1954, have progressed from an initial 12-in. diameter reactor to the present 4-ft., 20 tons per day, unit.

At the pilot plant the nickel sulphide filter cake is received in a 3·5 ton capacity rotary bin, from which it is discharged on to a 12-in. belt conveyor feeding the 5-ft. diameter balling disc. Roaster dust from cyclones and Cottrell, in an

amount equal to 10–25% by weight of the sulphide feed, is recycled to the filter cake conveyor, ahead of the balling disc. Dust and sulphide are mixed on the disc and formed into ⅛-in. diameter pellets which are fed to the roaster. Dust-laden roaster gases are cooled by water sprays and entrained dust collected in cyclones and an electrostatic precipitator for recycle. Calcine at 2,000° F. is continuously withdrawn from the reactor and cooled to about 200° F. by water sprays.

Preparation of well-formed dense pellets is of the utmost importance for efficient roaster operation, the authors say. Poorly pelletized feed invariably causes excessive dust during roasting. Also, inadequately controlled balling disc operation causes feed surges to the roaster. Temporary overfeeding may result in a momentary oxygen deficiency and danger of bed fusion. Underfeeding requires intermittent use of auxiliary fuel, making control difficult.

By test work a major factor in the formation of suitable agglomerates proved to be adjustment of the admixed liquid which had to be maintained between 7½% and 8½%. For best results this moisture should be present in the feed to the disc and addition of water at this point limited to less than 1%. Premixing of new sulphide feed and roaster dust in a paddle mixer proved to be highly beneficial. Not only did it improve the uniformity of the balling disc feed, but also the "fluffing" action of the mixer seemed to improve the pelletizing operation.

The 5-ft. diameter balling disc is 5½ in. deep and equipped with an 8-in. re-roll rim. The disc normally operates at 10 r.p.m. and is set at a 45° angle; its capacity is about 3 t.p.d. per sq. ft. of area, exclusive of that of the re-roll rim. Comparative tests on discs of varying sizes indicate that their capacity increases roughly with the square of the diameter.

Extensive test work was conducted to determine the effect of additives to the balling disc feed. Among those tried were nickel sulphate, sulphuric acid, and sulphite liquor (Lignosol). Results indicated a significant increase in green pellet strength, especially when use of these additives was combined with partial drying of the pellets. An interesting discovery made during studies on pelletizing was that part of the water in green pellets could be replaced by fuel oil. Surprisingly, such addition did not impair pellet quality, did not interfere with roasting operation, and avoided difficulties which might arise from separate addition of oil to the roaster.

A satisfactory self-cleaning feeder was developed. Two superimposed sliding gates are opened and closed alternately by means of solenoid-actuated pneumatic cylinders, thereby feeding green pellets to the furnace while maintaining a positive seal against the roaster gas pressure. The gates are kept clean by adjustable scrapers. The timing cycle is set to feed a batch of pellets every 5 sec. This feeder has also been used successfully for other difficult materials such as wet filter cake.

The fluid-bed roaster is a refractory-lined cylindrical shell, 4 ft. diameter at the hearth and 4 ft. 9 in. in the free board area. The overall height between constriction plate and roof brick is 34 ft. Bed depth and height of free board are approximately equal to those of larger commercial roasters.

The constriction plate consists of 61 stainless-steel clubhead tuyeres mounted at 5-in. centres in a mild-steel plate, protected by 2½ in. of insulating brick and 2½ in. of castable refractory. The open area of the grate is approximately 0·9%, which gives a 0·5 p.s.i. pressure drop with a flow of 1,100 s.c.f.m. oxygenated air for 30 t.p.d. sulphide feed rate. Space velocity is 7 f.p.s. in the bed and 5 f.p.s. in the free-board area. Particles smaller than about 100 mesh are elutriated from the bed and carried out in the roaster gas. Level of the expanded roaster bed is approximately 12 ft. above the grate. Pressure drop through the bed, exclusive of loss through the grate, is about 13 in. mercury.

Calcine is continuously withdrawn through a 4-in. inside diameter refractory-protected pipe. The rate of discharge is controlled by a plate seal. Calcine discharge rate is regulated by varying the distance between the plate and the discharge pipe. By raising the plate sufficiently the calcine seals by its angle of repose and flow stops completely. An additional advantage of the plate seal is that coarse material, such as lumps and pieces of refractory, are readily discharged.

Calcine overflowing the plate seal is sprayed with water and cooled to 200° F. This spray cooling is simple and positive and obviates the need for operating mechanical equipment under extremely severe conditions. Although decrepitation of calcine by thermal shock is negligible, the steam is vented to the electrostatic precipitator to collect any dust that may form.

Fine material entrained in the gases issuing from the roaster bed is only partially oxidized and it contains about 6% sulphur as semi-molten sulphides. It is essential, therefore, that gases and solids be cooled below the softening temperature of the sulphides prior to gas-solids separation. This is accomplished effectively by the evaporation of water introduced by a high

pressure atomizing spray inserted through the top of the furnace. Although cooling to about 1,100° F. is adequate to avoid " stickiness " of dust, roaster gas is cooled to 900° F. to prevent overheating of dust collection equipment. As a further safeguard in case of failure of cooling water sprays, an impingement plate has been installed ahead of the cyclones, to localize any build-up of fused material at a spot easily accessible for cleaning. A small amount of coarse dust which settles in the hopper is continuously returned to the roaster.

Dust-laden gas, cooled to 900° F., passes through two 20-in. diameter cyclones connected in parallel, where 86% of its dust burden is collected into a portable bin and thence returned to the balling disc. The gas passes to an experimental electrostatic precipitator, consisting of a single compartment energized at 41 kV by a mechanical disc rectifier. It provides a treatment length of 4 ft. and a treatment time of 1·2 sec. at 3·3 f.p.s. gas velocity. The total dust burden to the cyclones and Cottrell is about 25% of the sulphide feed.

Concrete Brattice in a Rand Shaft

A note in the *South African Mining and Engineering Journal* for March 10 refers to the fact that in recent years several new shafts on the Rand have been equipped with concrete brattice walls to provide upcast and downcast ventilation in the same unit. At Free State Geduld, following the disclosure of large tonnages of high-grade ore in the south-western portion of the lease area, it was decided to sink No. 1A ventilation shaft some 4,000 ft. south of the existing No. 1 shaft in the so-called " dome area."

At that stage it was thought that the whole section could be exploited from No. 1 shaft. Later investigations, however, revealed the existence of a considerable body of ore further south, which, as a result of upthrow faulting, cannot be economically reached from No. 1 shaft. To exploit it No. 4 shaft is being sunk adjacent to No. 1A ventilation shaft.

In order to gain access to this area and undertake initial development and cut stations and the like for No. 4 shaft it was decided to modify No. 1A shaft so that it can be used for hoisting and ventilation until No. 4 shaft is completed, when it will revert to its original function. No. 1A shaft has a lined diameter of 22 ft. and was sunk to a depth of 5,135 ft. It had been completed when the decision was taken as to how the area was to be opened up. In consequence, the brattice wall had to be built from the bottom upwards. Furthermore, as it is of a temporary nature—to be removed when No. 4 shaft is commissioned—it was undesirable that it should be chased into the shaft lining.

The method adopted was to bolt precast concrete slabs, 20 ft. wide, 4 ft. high, and 6 in. thick, weighing about 3½ tons each, into concrete studdles which had been bolted into the shaft lining. The studdles are 10 ft. long and weigh about ¾ ton each. Casting beds were set near the shaft site and the slabs were pre-stressed with 48 high-tensile wires. Concrete was delivered from the mixer to a motorized hopper running on a monorail. At the casting beds the hopper was lifted by a travelling gantry and dropped on to movable distribution chutes running on rails on top of the moulds.

For actual installation of the slabs in the shaft a special stage was designed and constructed on the mine and attached to the bottom of the six-decker stage used for sinking. It was hung in two halves on either side of the wall, so that work could be conducted simultaneously at different levels if need be. The technique used was to install several hundred feet of studdles and then return to grout and bolt the slabs into position, inserting packing between each slab to obtain an effective air-seal. Particular care had to be taken with the latter operation, as it is obvious that, with having to work from the bottom up, it was impossible to go back any distance once the slabs were in place.

The whole job was completed in 33 days—involving an average of 155 ft. of slabbing a day—which was well in excess of expectations. Peak performance was the installation of 450 ft. of studdles and 440 ft. of slabbing in a single day.

Although the method had to be devised to meet special conditions and the ventilation system has yet to be brought into operation, it seems to have possibilities—particularly when only temporary bratticing of a shaft is required—as it combines speed with the minimum disturbance of the permanent shaft lining.

Grinding in Cyanide

A note in the *Journal* of the Chamber of Mines of Rhodesia for February describes "Grinding in Cyanide Solution at Patchway Mine." This property, the author, W. S. Johnston, says, is situated some 12 miles north-west of Gatooma. It is now a subsidiary of Rio Tinto Rhodesian Mining, Ltd., who acquired it in May, 1960, from Anmor Mines and Minerals, Ltd.

At the beginning of 1960 the reduction plant operating at Patchway consisted of small jaw-crushers reducing the ore to a suitable size to feed a 22-in. Symons cone-crusher, which further reduced it to ¾ in. An 8 ft. by 5 ft. Allis-Chalmers ball-mill ground this product in water to approximately 60% *minus* 200 mesh, after which hydrocyclones separated the sand and slime. The slime was pumped directly to a slimes dam. The sand product passed over three James tables, the tailings being pumped to a sands dump while the concentrates were further upgraded on a fourth James table. Two cuts were taken from this table, the first for amalgamation, the second being sent direct to the Que Que roasting plant; the tailings from this table were returned to the ball-mill.

The slimes at one time was cyanided in Devereaux tanks, but this was discontinued in 1959 and the slime merely stored in a dam. The sands were treated in the usual manner of leaching, the final pregnant solution being precipitated in zinc boxes.

In the earlier part of 1960 considerable research work was done in the metallurgical research laboratory of the Cam and Motor mine on the practicability of grinding the total ore in cyanide solution. These tests, *plus* practical experience of this method of gold extraction which had been gained on another mine, led to the decision to convert the Patchway process to milling in cyanide solution instead of water. The changeover took place in August, 1960, the present procedure being designed to handle 150 tons of ore per day. Since the sand and slimes dumps were to be re-treated it was decided to reduce the ore milled and treat both sand and slime along with the current ore from Patchway and Big Ben mines.

The Big Ben mine, situated five miles north-east of Patchway, is connected to Patchway by a private road over which the ore is transported in 5-ton lorries. The ore is weighed at Big Ben, then hauled across and tipped into a receiving bin on the west side of the Patchway plant, whence it is fed to an Allis-Chalmers crusher *via* radial doors in the bin followed by conveyor-belt. A 1½-in. grizzley placed before the crusher discharges the undersize product to a conveyor-belt, which also picks up the discharge from the crusher and transports it to a 100-ton crushed-ore bin.

Patchway ore is hoisted in cars which are pushed from the shaft and tipped a few feet away over 2-in. grizzleys. The *plus* product is then hand-fed to two 9 in. by 15 in. Hadfield crushers also set to 1½ in. This product joins the grizzley undersize in a bin of 200-ton capacity. If and as required ore may be drawn from either the Big Ben bin or the Patchway bin for further reduction in a 22-in. Symons cone-crusher set to ½ in. Before reaching the Symons crusher the *minus* ½-in. fraction is removed by vibrating screens. The *minus* ½-in. product both from the screens and the crusher is transferred to a 110-ton capacity fine-ore bin by means of a bucket elevator. Dust in this section is eliminated by fan and collected in a specially-designed water trap. Sampling of the two ores is done at the bucket elevator during the crushing period.

Under the fine-ore bin two EMR6 Vibro-Verken feeders are fitted which feed the ore to the 8 ft. by 5 ft. Allis-Chalmers ball-mill. A solution of approximately 2% KCN is also fed to the mill. No lime is added at this point. The sands and slime mentioned previously are pulped in cyanide solution and pumped up to join the mill discharge where all are then delivered by pump to a primary 12-in. cyclone. The overflow of this cyclone at 65% to 70% *minus* 200 mesh is classified again in an 8-in. cyclone where an overflow of 85% to 90% *minus* 200 mesh is produced for delivery to the pachucas. The underflow of both cyclones return to the ball-mill feed.

There are four pachucas in series measuring 27 ft. 6 in. by 10 ft. diameter, giving a total contact time of approximately 9 hours. Here lime and lead nitrate are added. The pulp flowing from one pachuca to the other eventually gravitates from the last one into a 40-ft. thickener.

The pulp is thickened to nearly 65% solids when it is pumped by diaphragm pump to a 10 ft. by 8 ft. diameter Dorr-Oliver filter. The filtrate from this filter is returned to the thickener and eventually overflows with the clear solution to one of two 21-ft. sand clarifiers. The residue from the Oliver filter is repulped with water and finally pumped to a slimes dam.

The sand-filtered solution is further clarified in a Merrill Crowe bag clarifier treated with zinc

dust for gold precipitation and filtered through a leaf filter press. Fortnightly clean-ups are made and the zinc-lead-gold slime smelted in an oil-fired andalusite-lined furnace.

Treatment of the dump sand consists of hand-tramming in a cocopan which is hoisted to a wooden bin holding 100 tons. A reciprocating feeder set to feed 40 tons per day pushes the sand into a vortex mixer to which barren cyanide solution is added. The slime situated not far from the vortex mixer is hand-fed to another vortex mixer. This mixer, also containing cyanide solution, overflows and gravitates to the first mixer where both the sand and the slime are pumped to the ball-mill discharge. Regular sampling of the sand and slime is done before addition to the mixer. The average overall recovery since starting the plant is 93·1%.

The following figures show the average consumption of the various reagents used in the reduction plant :—

Cyanide.—0·77 lb. per ton of ore crushed.
Lime.—3·07 lb. per ton of ore crushed.
Lead Nitrate.—0·68 lb. per ton of ore crushed.
Zinc.—0·09 lb. per ton of solution or 1·65 lb. per oz. of gold precipitated.

Bleeding of cyanide solution is not necessary with the circuit at Patchway. Barren solution is used on the sprays of the Oliver filter and, since dissolved gold amounts to less than 0·10 dwt. per ton in the residue cake, enough cyanide solution is retained in the slime residue to keep the plant solutions sufficiently free of cyanicides. A continuous drip of ferrous sulphate added at the residue pump sump ensures that no harmful cyanide leaves the plant.

When pyrrhotite and certain other pyritic minerals are encountered a fairly strict chemical control of the circulating solutions must be maintained, otherwise very high cyanide consumption and low gold extraction followed by poor precipitation will be experienced.

Trade Paragraphs

Hadfields, Ltd., of Sheffield, have produced a catalogue of fine steels for general engineering purposes which gives extensive information on the composition and properties with identifying brand numbers.

Saxon Engineering Co., Ltd., of Fenton, Stoke-on-Trent, in an illustrated booklet describe their heavy-duty vibratory screens, resiliently mounted vibrating screens, reciprocating screens, and complete screening, handling, and storage installations.

Sumo Pumps, Ltd., of Crawley, Sussex, have produced a smaller version of their drainage pump suitable for 2-in. bore hose, 2-h.p. rating, and capacities of 3,000 g.p.h. at 52 ft., 4,000 g.p.h. at 47 ft., 5,000 g.p.h. at 39 ft., and 6,000 g.p.h. at 29 ft.

Hird-Brown, Ltd., of 244, Marsland Road, Sale, Cheshire, are now making an emergency stop device for conveyors operated by a light beam and photo-electric cell. It becomes effective immediately an operator's hand is pressed over the conveyor and is arranged also to fail safe.

Frederick Parker, Ltd., of Leicester, are dispatching to Oruro, Bolivia, for Tihua Mines, two apron feeders, a 16 in. by 10 in. Rocksizer crusher, an 18 in. by 14 in. Rollsizer roller-bearing crushing roll, two belt-conveyors 16 in. wide and 100 ft. long, and two belt apron feeders, all with control gear.

Laporte Industries, Ltd., of 1–5, New Bond Street, London, W. 1, announce that the Fullers' Earth Union, Ltd., of Redhill, Surrey, have concluded an agreement with the Archer-Daniels-Midland Co. of New York, to act as sole distributor for sales of " Federal Green Bond " bentonite in the United Kingdom.

BTR Industries, Ltd., of Herga House, Vincent Square, London, S.W. 1, are to be among the exhibitors at the British Trade Fair in Moscow starting next month. Conveyor belting for underground and surface work, including the new Nypac specially suitable for resistance to acid or other chemical contaminants, will be the principal feature.

Dowty Mining Equipment, Ltd., of Ashchurch, Glos., have an exhibit at the forthcoming British Trade Fair in Moscow, where they will be showing their well-known roof support equipment. This will include the Roofmaster self-advancing system of support, hydraulically powered, the Duke yielding hyraulic prop which allows for roof convergence, and the hydraulic chuck suitable for the waste edge.

Imperial Chemical Industries, Ltd., of Imperial Chemical House, Millbank, London, S.W. 1, refer in a recent note to the installation of a trial quantity of p.v.c.-coated Terylene ventilation ducting at the ironstone mine at North Skelton, Yorks., of Dorman Long (Steel), Ltd.

The ducting, as illustrated, has been found easier to handle because of its relatively light weight. It was made by **Robert Watson and Co., Ltd.,** of Newburgh, Fife.

Goodyear Tire and Rubber Co., of Akron, Ohio (British office: Goodyear Tyre and Rubber Co. (Great Britain), Ltd., Wolverhampton), draw attention to a new woven carcass rubber conveyor-belt introduced recently, which is especially suitable for iron ore and hard-rock mining because of its capacity to be vulcanized into an endless unit in the field and is known as Uniflo. Produced in continuous lengths without cover seams, Uniflo features a carcass of nylon-reinforced cotton yarn woven into a special interlocking complex.

Thomas Smith and Sons (Rodley), Ltd., of Leeds announce that a new independent high-speed derrick unit and a new swing brake are now available for their Smith "12" excavators and crawler cranes. These two units will enable the crawler-mounted machine to hoist, slew, and derrick simultaneously, and if used in conjunction with the special planetary-load-lowering drum unit which is also available, will complete the equipment for tranforming the "12" into a sensitive precision crane. All this equipment is now available in the form of optional extras on new machines.

Hunting Associates, Ltd., of 1450, O'Connor Drive, Toronto, state that Operation Overthrust—described as the largest geological compilation of its kind in the world—is now available in single-sheet form. It covers 372,000 sq. miles of the Precambrian Shield in Canada and an adjoining part of the United States and it consists of 500 individual photomosaic sheets, each covering an area of approximately 720 square miles, and with a separate transparent overlay showing all geological data and pertinent geophysical interpretation.

Engineering Laboratory Equipment, Ltd., of 285, Ealing Road, Alperton, Wembley, Middx., has been formed jointly by **Soil Mechanics, Ltd.** (a member of the Mowlem Group of Companies), and **Griffin and George, Ltd.,** to provide a comprehensive service at home and overseas. The knowledge and experience of both organizations will be combined to provide for the design, construction, and furnishing of engineering laboratories, together with the manufacture and supply of all the necessary testing apparatus and equipment backed by a comprehensive after-sales service.

Johnson, Matthey and Co., Ltd., of 73–83, Hatton Garden, London, E.C. 1, are now able to offer in quantity two grades of mercury for laboratory and industrial use. Redistilled mercury has a maximum impurity content of 5 parts per million (mostly copper and silver) and triple-distilled mercury a maximum of 1 part per million. Every batch is examined spectrographically to ensure that the limits are not exceeded. The metal is supplied in 7-lb., 14-lb., or 28-lb. containers, though other packings can be provided. The product is described in a newly-issued data sheet in the Electrical Engineering series.

Joy-Sullivan, Ltd., from their air power division at 7, Harley Street, London, W. 1, state that they have recently delivered to Norway two portable 600 c.f.m. air-compressors which are the first to be fitted with Rolls-Royce engines—namely, six-cylinder, 170-h.p. diesel with cold start boosters. They also announce that their associate company Joy-Sullivan (Africa) Pty., Ltd., have received an order from Canada for the No. 50 core-drill, described as the largest of its type and capable of drilling a 2-in. hole to a depth of 12,000 ft. Machines of this type were used extensively in the drilling of the Orange Free State and Far West Rand goldfields. Another and somewhat smaller drill—the No. 45—has been ordered by the British company from South Africa for shipment to the East.

Cyanamid of Great Britain, Ltd., of Bush House, Aldwych, London, W.C. 2, call attention to two new explosives for use in seismograph exploration which are now available from the

Mining Chemicals Department of Cyanamid International—namely, Cyamon S blasting agent and Cyamon S primer. The blasting agent is a nitro-carbo-nitrate that requires a primer for detonation and is packaged in hermetically-sealed cylindrical containers. Each cylinder is threaded to permit easy coupling for the forming of column loads. Depending upon the column length of the charge and the practice of the operator occasional booster primers may be added. Cyamon S primer can be coupled to the blasting agent through the threaded connexions of its cylindrical metal package. The female end contains a recessed well for cap insertion that will accommodate any seismic cap now available.

Engineering, Marine, Welding, and Nuclear Energy Exhibition

The Engineering, Marine, Welding, and Nuclear Energy Exhibition, held every two years, opens in London at Olympia on April 20 and ends on May 4. Advance information has been made available from some exhibitors from which extracts follow :—

British Oxygen Co., Ltd., of Bridgewater House, St. James's, London, S.W. 1, in their main exhibit will show a model of an oxygen producing plant, the theme being that they have a distribution system for oxygen whether required by the ton or by cylinders. A propane supply service will also be featured as well as other industrial gases. In the welding section there will be examples of their products for electric and Argonarc welding.

George Cohen, Sons and Co., Ltd., of Wood Lane, London, W. 12, are to be represented for the first time for several years by their sheet metal working machinery department.

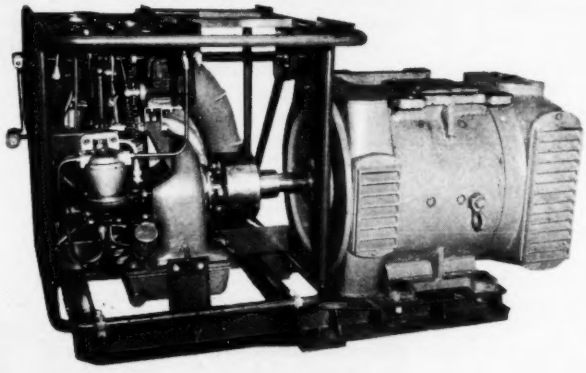
Lee, Howl and Co., Ltd., of Tipton, Staffs., are to show a multi-stage, split-casing, high-speed turbine pump suitable for outputs of 17,000 g.p.h. against 2,000 ft. This is a modification of an original range which runs at 2,900 r.p.m. and is suitable for mine drainage.

Goodyear Pumps, Ltd., of 44, Brook Street, London, W. 1, include in the range to be shown a pump in stainless-steel form of particular interest to chemical users having a speed range from 500 to 3,000 r.p.m.

Megator Pumps and Compressors, Ltd., of 43, Berkeley Square, London, W. 1, in addition to a range of pumps suitable for mining duties will be showing for the first time at this exhibition a float switch for the control of levels in bulk storage vessels.

Murex Welding Processes, Ltd., of Waltham Cross, Herts., in their display will mainly emphasize the use of automatic welding and include a typical installation for general and Class 1 work, featuring a demonstration of their automatic welding head. New and improved versions of manual metal-arc electrodes will also be shown.

Palmer Aero Products, Ltd., of Herga House, Vincent Square, London, S.W. 1, will call attention to the development of a unique orbital welding method which allows a preformed tube to be joined automatically to an end fitting. Stainless-steel and nickel-based alloy pipes will be shown that have been welded by this method.



Perkins Mars 50-h.p. Gas Turbine Instruction Set.

Perkins Gas Turbines, Ltd., of Peterborough, are to show for the first time two new gas turbine generating sets and an instruction set (see illustration). One is a d.c. generator continuously rated to give 30 kW at 220 volts at a speed of 4,400 r.p.m. The other rated at 525 b.h.p. is coupled to a 330 kW unit and runs at 1,800 r.p.m. The instruction unit consists of a 50-h.p. turbine fitted with dynamometer and special equipment to measure its performance. In a separate note the company refer to a new 600-h.p. gas turbine being developed by the Solar Aircraft Co., of San Diego, California, which they are to manufacture and which runs at 21,500 r.p.m.

Saunders Valve Co., Ltd., of Cwmbran, Mon., will have examples of rigid P.V.C. valves intended for solvent welding to rigid P.V.C. pipework and for which a range of diaphragms is available. Ruber-lined non-return valves will be included and also solid type valves for special chemical uses. Standard models of the company's Safran pumps will also be on show.

Turner Bros. Asbestos Co., Ltd., of Rochdale, as a principal feature will be drawing attention to the Poly-V drive, already described in the MAGAZINE, in power transmission beltings. Examples of their conveyor belting will also be shown.

Worthington-Simpson, Ltd., of Newark, Notts., are to show a new high-head centrifugal pump capable of handling 920 g.p.m. against a total head of 440 ft. and having a maximum capacity of 1,700 g.p.m. against 340 ft. Also to be included is a new single-stage self-priming pump for heads up to 500 ft., with a two-stage unit for a head of 750 ft. when run at 3,500 r.p.m.

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

8, 653 of 1957 (860,786). SOBERTIZ, SOC. DE BREVETS, D'EXPLOITATIONS ET DE RECHERCHES METALLURGIQUES. Electrolytic production of titanium and zirconium.

16,785 of 1957 (860,791). F. L. SMIDTH AND CO., A.S. Calcination or sintering of lime, ores, etc.

18,714 of 1958 (860,798). SLOVACKE STROJIRNY, NARODNI PODNIK. Rotary earth-boring machine.

11,070 of 1959 (861,495). MOND NICKEL CO., LTD. Apparatus and methods of carrying out reactions between gases and solids.

16,093 of 1959 (860,335). PECHINEY CO. DE PROD. CHIMIQUES ET ELECTROMETALLURGIQUES. Electrolytic production of tantalum.

17,340 of 1959 (860,707). NEW JERSEY ZINC CO. Production of titanium.

31,048 of 1959 (860,555). E. J. LONGYEAR CO. Core drilling apparatus.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

Microwave Ferrites : By P. J. B. CLARRICOATS, with a Foreword by H. M. BARLOW. Cloth, octavo, 260 pages, illustrated. Price 50s. London : Chapman and Hall, 1961.

Mines in the Spinifex : The Story of Mount Isa Mines. By GEOFFREY BLAINEY. Cloth, octavo, 242 pages, illustrated. Sydney : Angus and Robertson (Publishers) Pty., Ltd.

The Mines of Cornwall : IV.—The Redruth Area. Statistics and observations by THOMAS SPARGO, 1865. Paper covers, 32 pages, illustrated. Price 5s. Truro : D. B. Barton, 1961.

The Coal Situation in Europe in 1959/1960 and Future Prospects. Paper typescript, 73 pages, with Annexes. Price 5s. United Nations Publication.

Experimental Coal-Burning Gas Turbine : Exhaust-treated Cycle. By J. W. STACHIEWICZ and D. L. MORDELL. Dept. Mines and Technical Surveys, Ottawa, Mines Branch No. 867. Paper covers, 176 pages, illustrated. Price $4.00. Ottawa : Queen's Printer.

Somaliland Protectorate : Geological Survey Report No. 4. Geology of the Berbera–Sheikh Area (Quarter Degree Sheets Nos. 24 and 36). By JOHN A. HUNT. Paper boards, 27 pages, illustrated, with maps. Price Shs. 20/–. London : Crown Agents for Oversea Governments and Administrations.

Survey of the Primary Zinc Industry in Canada, 1959. Mineral Resources Division Information Bulletin MR. 43. By D. B. FRASER. Paper covers, 83 pages, illustrated. Price 50 cents. Ottawa : Dept. of Mines and Technical Surveys.

The Geology of Sarawak, Brunei, and the Western Part of North Borneo. By P. LIECHTI, in association with F. W. ROE and N. S. HAILE. Paper boards in two volumes, I (text) and II (portfolio) maps. Price M$21 or 49s. Kuching, Sarawak : Geological Survey Department.

A History of Flow Measurement by Pressure-Difference Devices. Paper folio, 52 pages, illustrated. Price 10s. Luton, Beds. : George Kent, Ltd.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

***Industry, Africa :** *Mining, 1960.* South African Mining in 1960. L. A. WASPE, THE MINING MAGAZINE, Apr., 1961.

Industry, Australia : *Mineral, 1960–1961.* The Australian Mineral Industry, 1960–1961. J. A. DUNN, *Min. Chem. Engg. Rev.* (Melbourne). Jan. 10, 1961.

Production, Canada : *Asbestos, B.C.* Cassiar Production Value Approximates $10,000,000 Yearly. *Western Miner,* Feb., 1961.

Production, Chile : *Iron Ore, Carmen.* Modernization Adds 1 Million Tons per Year Iron Ore to Chile's Mina Carmen. A. T. YU, *Engg. Min.J.,* Mar., 1961.

Production, Egypt : *Metal, Review.* Metal Mining in Egypt. G. A. SCHNELLMANN, *Min. J.,* Mar. 10, 1961.

Production, United Kingdom : *Anhydrite, Cumberland.* Developments at Sandwith Anhydrite Mine. *Mine. Quarry Engg.,* Mar., Apr., 1961.

Production, United States : *Copper, Arizona.* Ray Div.'s 50% Milling-Capacity Boost Pays Dividends in Efficiency and Safety. J. B. HUTTL, *Engg. Min. J.,* Mar., 1961.

†Resources, India : *Sands, Travancore.* The Beach Sands Industry in South India: A Fifty Year Review. P. VISWANATHAN, *Science and Culture,* Jan., 1961.

Resources, Canada : *Mineral, Far North.* Challenges and Opportunities in Developing Canada's Northland. W. S. KIRKPATRICK, *Western Miner,* Feb., 1961.

Resources, United States : *Fluorspar, Colorado.* Geology and Fluorspar Deposits, Northgate District, Colorado. T. A. STEVEN, *U.S. Geol. Surv. Bull.* 1082-F.

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Economic, United States : *Fluorspar, Colorado.* Geology and Fluorspar Deposits, Northgate District, Colorado. T. A. STEVEN. *U.S. Geol. Surv. Bull.* 1082-F.

Economic, United States : *Tin, Alaska.* Placer Cassiterite of the Manley Tin Belt. K. W. STANLEY, *Econ. Geol.,* Jan.–Feb., 1961.

Genesis, Ore : *Isotopes, Data.* The Data of Lead Isotope Geology Related to Problems of Ore Genesis. R. S. CANNON and others. *Econ. Geol.,* Jan.–Feb., 1961.

Regional, Africa : *Kenya, Northern.* (1) Geology of the Bur Mayo–Tarbaj Area. A. O. THOMPSON, R. G. DODGSON, *Geol. Surv. Kenya Report* No. 47. (2) Geology of the Mid-Galana Area. L. D. SANDERS, *Geol. Surv. Kenya Report* No. 46.

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†Gold, Cyanidation : *Grinding, Rhodesia.* Grinding in Cyanide Solution at Patchway Mine. W. S. JOHNSTON, *S. R. Chamber of Mines J.,* Feb., 1961.

Granulation, Liquid-Iron : *Process, United Kingdom.* Granulation of Liquid Iron. H. E. STORR, T. RUDKIN, *Iron, Coal Tr. Rev.,* Mar. 24, 1961.

Hydrometallurgy, Leaching : *Concentration, Acid.* Conductimetric Measurement and Control of Acid Concentration in Leach Pulps. G. G. EICHHOLZ, A. H. BETTENS, *Canad. Mines Branch Tech. Bull.* TB 17.

Iron, Canada : *Production, B.C.* Cominco Commences Iron Production at Kimberley. *Western Miner,* Feb., 1961.

Preparation, Iron-Ore : *Plant, United Kingdom.* Home Ore Preparation at Corby. D. PARKINSON, *Iron, Coal Tr. Rev.,* Mar. 31, 1961.

†Roasting, Fluidized : *Nickel, Canada.* Fluid Bed Roasting of Nickel Sulphide. W. CURLOOK, H. J. ROORDA, *Canad. Min. Metall. Bull.,* Feb., 1961.

Steel, Refining : *Degassing, Vacuum.* Ten Years' Large-Scale Vacuum Degassing of Steel. K. WERNER, *Iron, Coal Tr. Rev.,* Mar. 10, 1961.

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***Alloys, New :** *Columbium-Vanadium, Tungsten-Tantalum.* Columbium, Vanadium, and Tantalum Base Alloys. THE MINING MAGAZINE, Apr., 1961.

***Carborundum, History :** *Development, Uses.* Carborundum. M. SCHOFIELD, THE MINING MAGAZINE, Apr., 1961.

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Platinum, History : *Experiments, Early.* The First Experiments on Platinum : William Brownrigg and His Scientific Work. J. RUSSELL-WOOD, *Plat. Metal. Rev.*, Apr., 1961.

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Coal, United Kingdom : *Cutter-Loader, Development.* Development of the Mawco Cutter Loader : Trials in the East Midlands. N. SIDDALL, *Iron, Coal Tr. Rev.*, Mar. 24, 1961.

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Shafts, Lining : *Construction, Watertight. Recent* Watertight Shaft Lining Construction. W. OSTROWSKI, *Canad. Min. Metall. Bull.*, Feb., 1961.

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